THE ENGINEERING RECORD

PUBLISHED WEEKLY BY THE

McGraw Publishing Company

MAIN OFFICES:
114 LIBERTY STREET, NEW YORK.
BRANCH OFFICES:
PHILADELPHIA: Real Estate Trust Bldg.
CHICAGO: 1140 Monadnock Block.
CLEVELAND: Cuyahoga Building.
LONDON OFFICE: Hastings House, Norfolk St., Strand.

SUBSCRIPTION RATES.

United States, Canada, Cuba and Mexico....$3.00 a year.
Foreign subscription ....$6.00 a year.
25 shillings. 25 marks. 31 francs.
Foreign subscriptions may be sent to our London office.

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Changes in advertisements intended for a particular issue should reach the office of THE ENGINEERING RECORD on Friday of the previous week. New advertisements can be received up to noon of Wednesday of the week of issue.

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Entered at the New York Post-Office as Second Class mail matter.

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Of this issue of THE ENGINEERING RECORD 12,000 copies are printed. Total circulation for 1906 to date 432,000 copies, an average of 12,706 copies per week.

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The Oiling and Tarring of Improved Roads.

The improvement of country roads has carried with it the necessity of finding some practicable means, if it is possible to do so, of making them as nearly as possible dustless. That end fully attained is probably far too much to anticipate, although it is reasonable to expect that the dust nuisance may soon be abated by proper treatment and maintenance of the road surface. It has been found, fortunately for the country at large, that nearly every locality has road materials more or less suitable for the construction of a high grade of road, although there are decided differences of excellence among these grades. Some crushed stone is much better than others, and some gravel road material will give better results than others, but as a whole it may safely be said that under suitable inspection every locality will afford satisfactory material for the improvement of its roads.

In every case, however, where sprinkling is not carefully and continuously resorted to, it requires but a few days' wear in dry weather to grind almost any road surface into so fine a powder that it is easily carried about by the wind, resulting not only in carrying away the road material, but creating an insufferable dust nuisance in connection with that operation. The problem is to find some feasible and agreeable method of avoiding these results in the absence of continuous sprinkling. The application of oil and tar have both been tried with varying success, depending upon the method or the conditions of application. In many portions of the country where the layman has heard that the application of crude petroleum is a good preventive of dust, that material has been sprinkled freely upon the ordinary surface of the road. The dust and loose particles less finely divided of course receive the oil and absorb it. The result is all too frequently a mealy mixture of dirt and crude petroleum of disagreeable odor and of such consistency that it is readily thrown into vehicles by the wheels, damaging the clothing of the occupants and the fittings of the vehicle itself. The conclusion is at once reached that the oil treatment is decidedly worse than nothing, especially as the result, after a period of dry weather, is no less dust than before and certainly of a not less disagreeable character. Almost the same observation can be applied to the application of tar in the same ignorant and inefficient manner.

In a recent issue of The Engineering Record there was published the results of certain tests of tar on macadam roads at Jackson, Tenn., and there have been many places throughout the country where both tar and crude petroleum have been applied to road surfaces with the most efficient and satisfactory results. Effective methods of application of these materials require but little if any more care than ineffective methods and probably are little, or no more costly. If town officials or country residents are minded to use crude petroleum or tar for the preservation of their road surfaces or for the abatement of the dust nuisance they should at least take sufficient pains to inform themselves carefully as to the proper methods of application involving the prior methods of treatment of the road surfaces. The dust and other loose material should be carefully cleaned from the entire road surface to be treated. This cleaning should be done in such manner as to be equivalent to a thorough scraping and sweeping, leaving absolutely uncovered the hard road surface beneath the ordinary dust layer. Furthermore, this hard cleaned surface should be absolutely dry, as unsatisfactory results are definitely certain to follow any application of either material to a wet or even damp roadway. If tar is used it must be heated to a proper temperature so as to be applied in the proper consistency. If the crude petroleum or tar is then sprinkled or applied properly to the exposed surface it will be absorbed by the latter, for which absorption ample time should be afforded. The action of the tar seems to some extent at least to produce a cemented mass, or covering, so to speak, as a part of the hard roadbed. After a sufficient time has elapsed to allow the oil or tar to be thoroughly absorbed by the material which receives it, traffic may be resumed and it will then be found that while the roads may not remain absolutely dustless for a long period of time, they will resist most effectively the raising of any sensible amount of finely divided material for a considerable period.

Enough experience has already been had in reference to these results to indicate that they may be satisfactorily reached under intelligent treatment on any improved road. Indeed, they constitute means or methods of maintenance that may well be resorted to in any locality where the best road conditions are desired to be attained, but it must be remembered that the application of either oil or tar must be conducted, like any other good road engineering work, with intelligence and scrupulously in accordance with those conditions which experience has shown to be absolutely essential for success.

Lightning Conductors.

Ever since Franklin devised the lightning rod it has been a subject of doubt and discussion. In early days there were those who held it to be an impious interference with Heaven's wrath, evil in principle and doubly sacrilegious if successful. In this connection it is interesting to note that Robespierre as a fledgling lawyer successfully defended a client haled to court by the ecclesiastic powers on the charge of sacrilege from having erected a lightning rod. Others have doubted its efficacy altogether and still others have treated it with superstitious reverence, decking it with platinum tips and gilded balls and insulating it as carefully as if it were an electroscope, and they consecrated priests of radium. As in most cases, truth is found along the middle course. A lightning discharge is fundamentally a condenser discharge in which clouds and earth are the electrodes and half a mile of air more or less the dielectric. More rarely the discharge is between cloud and cloud, but however the discharge occurs it is essentially a condenser discharge. It differs from the discharge of a Leyden jar, however, by reason of the enormous magnitude of the charges involved. As is well known, a Leyden jar discharge is oscillatory in character, the first rush of current reversing and dying away in diminishing waves. But the period of the oscillation is determined by the capacity of the jar, and when one is dealing with the prodigious charges of a cloud and the subjacent earth, the current is practically one tremendous rush, the reversal being damped out of existence. Now and then, especially between adjacent clouds, the capacity may be large enough and the resistance small enough to give oscillations, but this case is exceptional.

Given a heavily charged cloud overhead and the question of when the discharge will break through the dielectric is all-important and indeterminate. If the lower electrode, that is, the earth, bears conspicuous projections which are conductors as compared with air, the break is likely to take place at one of these points. As the projection becomes a larger and larger fraction of the total thickness of dielectric, that is, of the distance between earth and cloud, the chance of a local break increases. For example, the Washington Monument would always span a material fraction of this distance and be frequently hit, as experience has shown. Tall buildings, steeples and chimneys are, therefore, danger spots, as are high ridges across the path of a storm, especially when crowned with trees. Buildings wet with rain are poor conductors as compared with metals, but good ones as compared with air, so that they are apt to locate the point of puncture. Buildings very low as compared with cloud heights, say twenty or thirty feet in one or two thousand, do not sensibly weaken the insulation of the great air-gap. The quantity of a lightning discharge is at times enormous, the equivalent of many thousand amperes, and as the discharge takes place in a fraction of a second, the concentration of energy is very great and something has to give way. The principle of the lightning rod is locally to weaken the dielectric by putting a conductor far enough above buildings to determine the place of a threatened discharge and to carry it to earth without destructive results. Hence, the fundamental thing is to carry a conductor high enough to be well above any object to be protected and to make it big enough to stand the discharge without injury.

Very high structures are in these days often fairly good conductors, and it is seldom that a skyscraper is injured by lightning unless by the destruction of a flagstaff, the great metallic frame preventing any dangerous concentration of energy. Steel and masonry combinations in general tend to protect themselves. High chimneys, however, are apt to be injured at times and in these structures the main thing is to carry a rod high enough to deflect to itself the most of the energy. Iron ladders often serve the purpose, with an upper rod perhaps rising no higher than a diameter of the stack. One of the interesting problems is the protection of reinforced-concrete structures. There has hardly yet been experience enough with such to determine how much the reinforcing can carry lightning without injury, and the side of safety would seem to lie on enough localized metal to take care of the major part of the energy. If a special lightning conductor is used at all, it should be thoroughly well grounded, and of good cross-section, but insulated only by being carried slightly away from the wall in order to lessen the chance of scarring it locally. Fanciful cross-sections and elaborate terminal fixtures are of no consequence whatever, nor is the material of any particular moment, any metal being enough better than wood or masonry to serve the purpose. Iron serves as well as copper if in a liberal rod, say three-quarters of an inch to an inch in diameter. Possibly carefully pointed rods, if high enough and numerous enough, would tend to prevent the accumulation of charge above them and thus render lightning infrequent, but practically rods serve merely to determine the path of the discharge which from natural causes would take place in the vicinity, and thus to shield the building to which they are attached. The chief thing is to get well up above the structure, unless the framework is part of the conducting system, and to get the foot of the conductor into good wet earth. In high isolated buildings the rod plays a more useful part than elsewhere merely because such buildings are natural danger points. In the open country trees are the most efficient kind of conductors because they are sure to be well grounded.

Summing up the entire matter from a practical standpoint, any object that rises considerably above the general level of its surroundings is by this fact in more than usual danger from lightning and should be protected by conductors. The point or points should rise above the top of the structure at least a radius of the area designed to be protected. Buildings with grounded roofs or steel frames are themselves so good conductors that special additional conductors do not give enough extra conductivity to determine the discharge successfully. The material and shape of the lightning conductor makes little or no difference, so that tubes, straps and twisted conductors have only a fanciful value. An ordinarily heavy lightning discharge involves so great capacity that it is practically non-oscillatory and the chief point is to give the conductor cross-section enough to prevent its fusing and render it a first-class path to earth. The last condition must be completed by getting down to wet earth and setting the rod in a mass of damp coke or charcoal or attaching a ground plate. Where house rain leaders connect to dry wells, an ideal ground can be obtained by attaching the lightning conductor to a coil of wire or metal plate at the bottom of a well. The supports require no insulating sleeves, but should be carried a few inches from the building merely to prevent incidental damage. Lightning indulges at times in strange freaks and even the best rods may fail when used on bulky buildings which offer a large surface at an elevation nearly as great as the rod. The path of the air discharge is so erratic that it cannot be depended upon to take the nearest way. But in case of steeples, chimneys and the like, a substantial and well-grounded rod is very generally effective, especially if its terminal is well above the top.

The Foundations of the Manhattan Bridge.

A full description of the foundation work of the Manhattan Bridge now in progress will be found in another column of this issue of The Engineering Record. From one point of view it may be said that there is nothing remarkable of an engineering character in this great work, so common have become nearly all classes of engineering work of magnitude. Any bridge structure carrying eight standard-gauge railway tracks besides double decks of roadways and sidewalks, with a center span of 1,470 ft., is worthy of remark either from a public or professional standpoint, and yet so accustomed has the public become to witnessing great engineering operations that the construction of this bridge is being carried on practically without public notice. These general observations have particular bearing upon the construction of the foundations, one pier of which, 184 by 337 ft. in horizontal dimensions and 140 ft. high, is certainly a remarkable mass of masonry. It is unusual to find steel reinforcement used to a considerable extent in this work, little of it having been employed heretofore. Although pier masonry is ordinarily a mass of that material discharging its functions simply by its weight, experience has shown that in many positions the capacity to resist some degree of tension is not only advisable but absolutely necessary to prevent cracking. Although these cracks are usually of little or no real consequence, it certainly is advisable to avoid them, and where that avoidance can be accomplished by so simple a device as steel reinforcement there can be no question of the good judgment exercised in using it. Indeed, it is not unlikely that much of the massive masonry of the future will be reinforced to at least a small extent, enabling it in many cases where suitable to be lightened by open construction, even where the open work is concealed by backfilling.

It is interesting to observe that even in one of the anchorage piers, that for the New York side, the amount of all classes of masonry used is somewhat more than 150,000 cu. yd., in connection with which over 4,000 piles were driven. Nothing marks more emphatically advances made in the larger engineering works than these great volumes of foundation material massed into a single unit. Of far more interest than the contemplation of this remarkable mass of material as a whole are the plant and procedures requisite for putting it in place. The amount of machinery required at the site and the area of ground needed for it, together with the administration of the whole work when in progress, constitute a great engineering manufacturing plant. the running of which is as essential to efficient, satisfactory and successful results as the conduct of any other manufacturing establishment. It is no longer a mere matter of receiving various classes of rough material and handling them with coarse and ill-kept derricks or other affiliated plant, but every part of the great work, reaching from the reception of the materials to the completion of the pier, must be ordered with a most careful balance for fitting all operations of the plant so that no one shall be forced unduly ahead of the other, or fail to receive its material at the proper time. It would be absolutely impossible to complete successfully as a business matter, or to build anywhere near within a permissible period of time the members of such a bridge as the Manhattan stiffened suspension structure over the East River without as complete and nicely balanced an organization as that which characterizes any successful permanent manufacturing industry. Electric and pneumatic equipments are now almost universally employed, as they are in connection with the structure under consideration in order to secure desired results, and that observation holds not less true for the substructure than for the superstructure manufactured in permanent shops.

The progress so far made upon the Manhattan Bridge is satisfactory through the use of modern plant and methods under the most advanced degree of executive management of affairs in the field and if no more law suits intervene to bar this progress it will be but a comparatively short time before the completed structure will be available to relieve the phenomenal congestion of traffic between the Boroughs of Brooklyn and Manhattan.

Industrial Methods in Scientific Research.

Within the last half century many improvements have been effected in the administration of industrial work, and the day is probably not far distant when the direction of scientific research will proceed on much the same organized plane as the conduct of commercial enterprises. The importance of high operating efficiency in scientific research was pointed out by Prof. E. C. Pickering, of Howard Observatory in the Phi Beta Kappa oration this year at Howard University. Although interference with the plant of the investigator of genius may readily spoil them "a great observatory should be as carefully organized and administered as a great railroad. Every expenditure should be watched, every real improvement introduced, advice from experts welcomed, and, if good, followed, and every care should be taken to secure the greatest possible output for the money expended." This is the true industrial viewpoint, and it should appeal most forcibly to the business man who desires a definite result from, or at least a succinct report of what has been done with, the contributed means.

In the operation of a large observatory, a considerable part of the income is used for salaries, heating, lighting and repairs. Hence, a small increase in the resources will produce a disproportionate increase in the scientific results obtained. A great saving in routine computations can be made by employing unskilled and therefore inexpensive labor, though under careful supervision. In this way a great increase in results can be obtained from a moderate expenditure, and the amount can be estimated in advance. Astronomy is not the only science to which conditions of this kind apply, and in many other lines of research better organization would be the means of preventing much duplicated work, making available to investigators all over the world the results of experiments, observations and tests, and placing the best qualified man in touch with the kind of work most suited to him. Money expended in an organized way for scientific research results in reduced cost of production, increased output and carries no financial profit to those holding the funds in trust. In this country an excellent beginning has been made by the Carnegie Institution in the promotion of research by specially qualified investigators, and the Rockefeller donations are well known as gifts far removed from haphazard bestowal.

Valuable as organized methods are, it is important to realize that researches in pure science involve many disappointments in comparison with epoch-making triumphs, and that output in research may consist of many negative determinations even with the finest physical and mental equipment. The philanthropist who invests money in scientific research has a right to demand sufficient use of it, but positive results of immediate industrial importance cannot be guaranteed for each unit of labor and expenditures. These facts in no sense lessen the value of research, for if the laboratory door ever has to close for lack of funds, the industrial world will face a paralysis of progress which would in time become intolerable to civilized communities.

Power Transmission by Direct Currents.

The growing use of alternating current for traction purposes has naturally stimulated reciprocal activity in the betterment of direct-current apparatus in the direction of higher working voltage. Add to this the considerable discussion of high-voltage, direct current for such heavy work as the Victoria Falls project in South Africa and it becomes sufficiently evident that the older methods have not yet been definitely driven from the field. If the large alternating-current locomotives now about to be tried fulfill the hopes of the builders, it is safe to say that a quietus will be put on further speculation about direct-current tramway motors at 1,000 or 2,000 volts. For certainly considering the ease with which alternating-current energy can be generated and transmitted at 10,000 volts or so, the existence of thoroughly satisfactory alternating-current motors will leave no reason for bothering with so troublesome an affair as a constant-potential, high-voltage, direct-current motor. The suggestion, in fact, seems like a sort of last stand against the inevitable, so far as traction is concerned. If, however, the alternating-current traction motor bears out the predictions of its enemies, or makes only a half-hearted sort of success, there will be reason for leaving a try at the other horn of the dilemma. This much is certain, that the present favorite method of transmitting alternating-current energy at high tension, transforming it to direct current by rotaries and distributing this over a 500-volt working system is a sorry makeshift which must ere long be laid aside for the larger work of electrical traction. The cost of the conductors and the magnitude of the currents that must be dealt with condemn the system as a permanent method.

It is, however, undoubtedly possible to build traction motors of the sizes most frequently needed, say, from 50 to 200 lb., for voltages from 1,000 up to perhaps 2,000 volts. The problem of constructing such motors is purely one of commutation and within some such limits as these it can be solved. It is the same problem in another form that confronts the designer of the commutating alternating-current motor, and if it can be solved in one case it probably can be in the other, within perhaps somewhat different limits. In either case the extreme conditions of commutation imply a more expensive construction and a somewhat tenderer machine than is now usual. If one considers the two systems as a whole the alternating-current plan is still the simpler for large systems, so that were the motors on even terms, the natural preference would be still for the form utilizing alternating current directly. It may turn out, however, that it will be easier to build a robust 100 or 200-h.-p., 10,000-volt, direct-current motor than an alternating-current one of similar capacity, in which case the tables would be turned. If such a direct-current motor could be worked as high as 2,000 volts it would have an excellent chance for pushing the alternating-current motor hard. Now in the case of constant-current generators, machines of 40 to 50 amperes and 2,000 volts have been successfully built, so that the inference is not unreasonable that a constant-potential, series-wound generator, or motor will prove feasible at some additional cost. Its opportunity, therefore, turns upon the practicability of the big alternating-current motors now under construction. If they are thoroughly successful there will be small incentive to develop the direct-current type; if they show various defects, the latter type of motor will take a fresh start.

In the matter of general power transmission the situation is very different. At the distances and under the conditions usual in power transmission a direct-current system at constant potential, even at 2,000 volts, would have little field. It is possible, however, that at some voltage, insulation of alternating current will become so difficult that a constant-current system will involve the lesser evil. The insulation necessary in a line depends on the maximum voltage to which it is subjected. In this respect the direct-current system has always an advantage in the ratio of 1 : 1 : 43, since it is the alternating-current crest that counts. Beyond this the direct-current line is free from resonance, less subject to surging, and carries its full potential only at times of full load. It has thus a really considerable advantage in the maintenance of insulation. It pays for this in the extreme subdivision of units necessary in the plant. A capacity of 50,000 kw. in alternating-current practice would be carried in five to ten machines, according to the hydraulic conditions, and these big units are wonderfully simple, compact and cheap. In direct-current machinery at constant current, present practice indicates 500 kw as about the largest available unit for high voltage. Even granting the possibility of a 1,000-kw. unit, 50 machines would be required, costing at least twice as much per kilowatt as the alternating-current generators. If the line voltage were 125,000, which is a not unreasonable point, the plant would have to be in two circuits of 25 generators each, since 5,000 volts is extremely high for such power machines. Such an arrangement means splitting up the hydraulic units and complicating the system generally to a frightful extent. At the receiving end of the line a similar series of motors would receive the current and it would then be converted into alternating or direct current, as occasion required, by the directly-connected generators. This end of the proposition is not so bad, for motor-generators can in large units be pushed to an efficiency of over 90 per cent., probably 92 or 93 per cent. The extra cost entailed by extreme subdivision of plant, moreover, is a very serious amount, not less than half a million dollars in a plant of the size named even after allowing for transformers in the alternating-current system, and such a sum will pay for a lot of extra insulation and copper. At present 60,000 volts is the limit in alternating-current practice. There is every reason to expect that 80,000 or even 100,000 volts can be managed successfully. An insulator for the last-named pressure should stand at least 250,000 volts for a long period to allow a sufficient factor of safety. The same insulation would be at least equally safe for 150,000 volts direct current, and it is only when this region is reached, far beyond present practice or general needs, that the constant-current scheme needs to be considered seriously. If 5,000-kw. generators for 5,000 volts direct current could be readily built, the situation would take on a very different aspect, but at present a generator of one-tenth the output and half the voltage is larger than has been yet produced in America, so the issue is as yet hardly pertinent.

Notes and Comments.

The Wabash R. R. Connection with the mills of the Carnegie Steel Co. just above Pittsburg has been completed and the contract made between that railroad and the Carnegie Steel Co. about five years ago, whereby the former secures 25 per cent. of the tonnage of the Carnegie mills, will shortly become operative. The estimated annual tonnage, in and out-bound, of the Homestead, Duquesne and Edgar Thompson mills of the Carnegie Steel Co. is 16,000,000 tons, of which 4,000,000 tons will be now diverted to the Wabash R. R. The contract also provides for switching rights over the Union R. R., by which the connection is made with the Carnegie mills, enabling the Wabash R. R. to handle traffic from the plants of the Westinghouse Electric & Mfg. Co., the American Steel & Wire Co., the McClintock-Marshall Co., the American Sheet & Tin Plate Co. and numerous other large industries. The opening of this connecting railroad is the culmination of the entrance of the Wabash R. R. into Pittsburg. Five years and an immense amount of money have been spent in securing this entrance, but as yet the Wabash has not handled any freight out of Pittsburg.

Steel Making in Japan was almost a complete failure until the outbreak of the war with Russia. A very large and complete steel works, containing the most modern equipment was built several years ago at Wakamatsu by the Japanese Government, but as late as the middle of 1903 these works were regarded as almost a complete failure. The outbreak of the Russian war, however, entirely changed the conditions, the government appropriating 3,664,000 yen to the works out of the funds raised for war purposes; and according to reports from Japan, the establishment is now in a comparatively efficient condition. The output from the works last year was between 60,000 and 65,000 tons of steel; this year it is estimated to be 80,000 tons, and in 1907 will be from 120,000 to 130,000 tons. If the capacity of the smelting furnaces were increased, the output of the works could be raised to 180,000 tons, sufficient to supply the present needs of the country. Although the impetus which the war demands gave to the works are considered to be responsible for their present prosperous condition, and experience only will disclose whether this condition will continue in time of peace, it may be readily assumed that when such good results have been secured the Japanese will not permit the affairs of the establishment to lapse into their former state.

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Baltimore Paving Work has been much facilitated by decisions of the Maryland Court of Appeals on Aug. 9. The city authorities desired to get bids on several kinds of pavements before determining which particular kind was to be used. They also desired to award the contract to the bidder in such a competition whose materials, methods and prices seemed best for each street under consideration. This plan was adopted in order to secure as much competition as practicable on all paving work, which was not done under the old system of permitting each Councilman to decide what kind of pavement should be used on each contract in his ward. The new system was incorporated in an ordinance placing the decision as to the selection of pavements and award of contracts in the hands of the Commissioners for Opening Streets and the Board of Awards, and resulted in a material reduction in prices. In the particular case which was the subject of one of the suits just settled in favor of the city, the competition allowed was between asphalt block, bitulithic and vitrified brick pavements; the contract was awarded for bitulithic pavement, although lower bids on other materials were received. The Court of Appeals has upheld this procedure, its decision being substantially as follows: The Commissioners for Opening Streets have the power to put the three pavements mentioned in competition with each other and, after the bids have been opened by the Board of Awards, to select the one of the three to be used. The Board of Awards has the power to award the contract to the lowest responsible bidder on the kind of pavement so selected, even though a bid has been filed on some other material which was lower than the lowest responsible bid on the selected material.

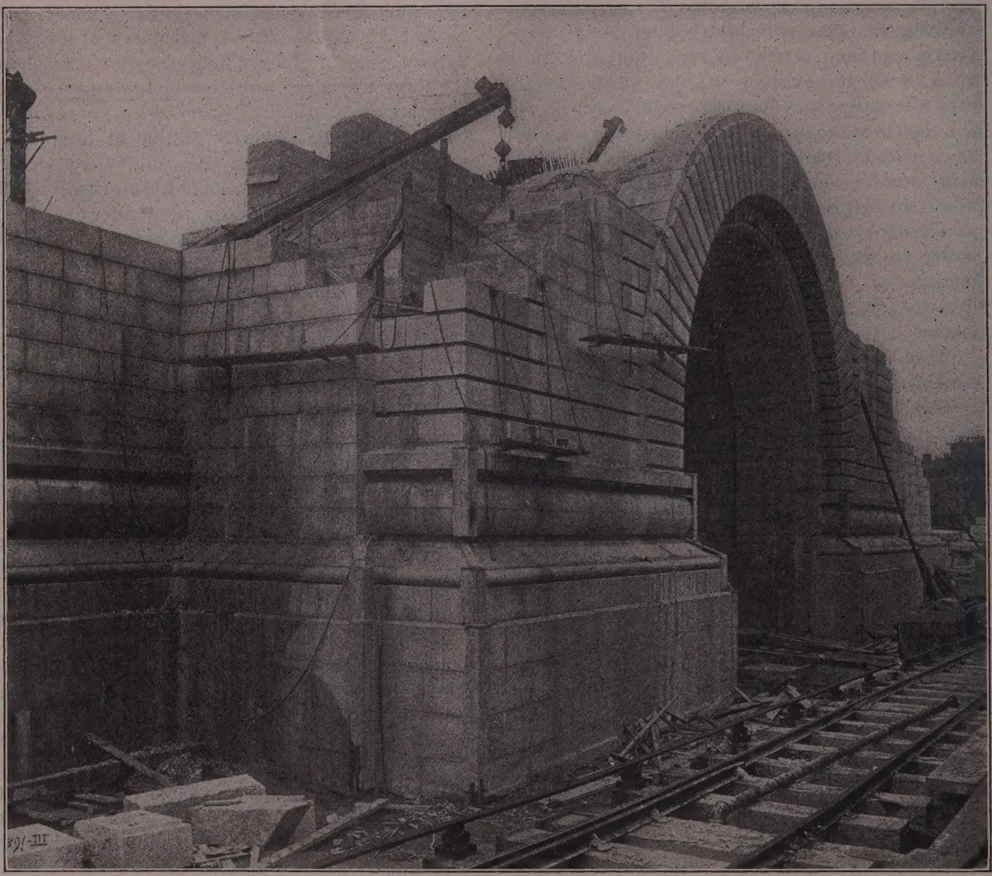
RECENT PROGRESS ON THE MANHATTAN BRIDGE, NEW YORK.

Construction Methods Employed on Masonry Anchorages of Great Magnitude.

Work is now well advanced on the substructure for the Manhattan bridge, which will cross the East River from Pike St., New York, to Adams St., Brooklyn, with a center suspended span of 1,470 ft. and two suspended approach spans of 725 ft. each, carrying double decks with four elevated railroad tracks, four electric street car tracks, one roadway and two sidewalks. The tower piers, 1,470 ft. apart, on centers, have pneumatic caisson foundations and have been completed for some time. The anchorage piers, about 2,890 ft. apart in the clear, are built within the bulkhead line with foundations in open excavation and are now under construction.

The Brooklyn pier is located at the intersection of Adams and Water Sts., with the axis making an angle of about 70 deg. with Water St., which passes full width through an archway built in the pier to receive it. The pier is rectangular in plan with extreme dimensions of about 182 ft. in width, 237 ft. in length and a maximum height of nearly 140 ft. above street grade. It will be one of the largest bridge piers in existence, and special pains have been taken to secure dignity and artistic merit in the design which is of a very massive character. The side elevations are relieved by the full-centered street arch of 46 ft. clear span and a height of about 46 ft. from the pavement to the crown. The arch is flanked with wide paneled buttresses and the top of the pier is finished with a simple massive cornice and balustrade at floor level, above which there are stone colonnades rising 40 ft. higher over the forward part of the pier. The front elevation of the pier has four buttresses in the planes of the main cables extending about 30 ft. forward of the front face of the anchorage, and is pierced with a central arch of 18-ft. 8-in. span. The rear elevation has corresponding rustic panels or pilasters, but no arch. About 8 ft. above the lowest point of the surface of the ground there is a projecting moulded base course, above which the walls are of plain, rough pointed face granite with projecting rustic pilasters and battered faces. The construction of the interior of the pier is complicated by the bearings and anchorages for the wire cables and by the arrangement of cross walls and intermediate floors. In some places, where solid masonry was unnecessary, cavities or chambers are formed to reduce the weight and volume of masonry, and these, together with the other special features, make a very complicated construction, the principal features of which are indicated in the general drawings published in The Engineering Record for Dec. 7, 1904.

The site was excavated with pick and shovel and with an orange-peel bucket to a depth of about 12 ft. below water level and about 25 ft. below street grade, the sides retained by heavy sheet piles and a foundation prepared by twenty-five hundred 40-ft. spruce piles driven by electrically operated drop hammers and high pressure water jets, as described in The Engineering Record of Aug. 12, 1905. On the tops of the piles a monolithic mass of concrete was deposited, covering the whole area of the pier to a depth of about 25 ft. and reinforced by horizontal Thacher steel bars of 1.56 sq. in. of cross section. Along the four sides of the pier these bars were 18 ft. long and 15 in. apart on centers arranged in double tiers close to the lower surface of the concrete. In the middle of the pier are 166 bars from 68 to 98 ft. long, laid longitudinally in each of four tiers about 1 ft. apart vertically.



Granite Voussoirs of Main Arch, Brooklyn Pier.

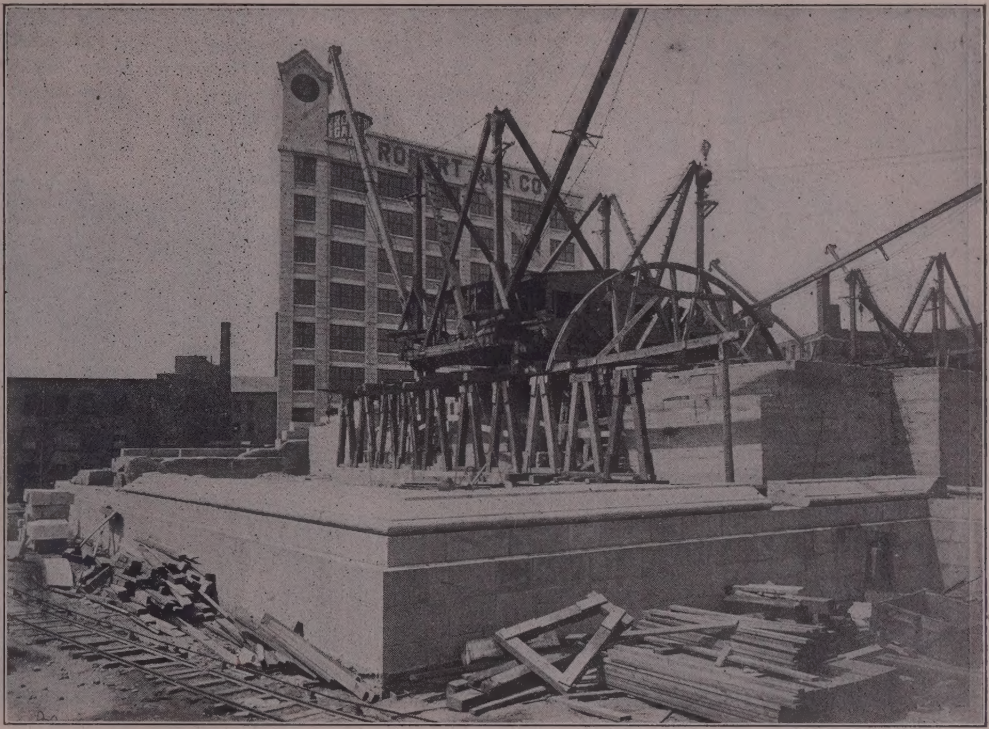
Above the footing the outer walls are made with massive granite blocks in 2-ft. courses, with one header to two stretchers. The widths and lengths of the blocks correspond with their rise, giving them an average weight of three or four tons each. Some of the pieces of cut stone in the mouldings and buttresses are much larger, the maximum being about nine tons. Under the archway the footing is of reinforced concrete only, but on each side of it cyclopean stone are bedded in the concrete and above grade the backing between the arch and the exterior walls is of concrete, in which are placed approximately cubical cyclopean stone of ½ yd. or larger sizes, set so as to avoid continuous horizontal beds and separated in all cases at least 6 in. The main arch is built with face rings of cut stone 11½ ft. deep. Adjacent to them are panels of stone voussoirs having in all a length parallel with the axis of the arch about 18 ft. from the face of the pier. These voussoirs are made with headers and stretchers of alternate depths of 2 and 4 ft., forming a bond with the concrete backing, which is about 5 ft. in radial depth at the crown and about 12 ft. at the springing line. The panels of the arch intermediate between these four stone arches are about 30 ft. long for the side and 28 ft. long in the center and have no stone voussoirs, being made wholly of reinforced concrete faced with concrete composed of limestone and Portland cement, the concrete being rough point dressed, to correspond with granite facing. The arch reinforcement consists of tiers of bars similar to those in the footings, one set of which is parallel to the intrados, just clearing the voussoirs, and the other set is parallel to the extrados and about 12 in. clear of its upper surface. The bars are made in convenient lengths overlapping about 3 ft., where they are considered to be spliced by the concrete itself. Eight heavy, longitudinal walls of reinforced concrete are carried across the main arch, parallel with bridge axis and enclose the different chambers for the anchor chains and open spaces. These walls are built in ordinary forms and are bonded to the arch concrete by steel reinforcement bars, 6 ft. long, bedded half way in the latter and projecting from it at various angles with the vertical.

The granite is received in about equal quantities from the Benvenue quarries, Stonington, Me., and cut near Middletown, Conn., and from Hall's Quarry, Me., owned by Arthur MacMullen & Co. The concrete, except for the floor slabs and steel protection is made, one part cement to seven parts of a 1:2 mixture of sand and 1½-in. broken stone, Helderberg Portland cement being used throughout. The pier contains about 42,000 cu. yd. of concrete, 60,000 cu. yd. of cyclopean masonry and 14,000 cu. yd. of granite, of which a total of about 58,000 cu. yd. of all classes of masonry has now been laid.

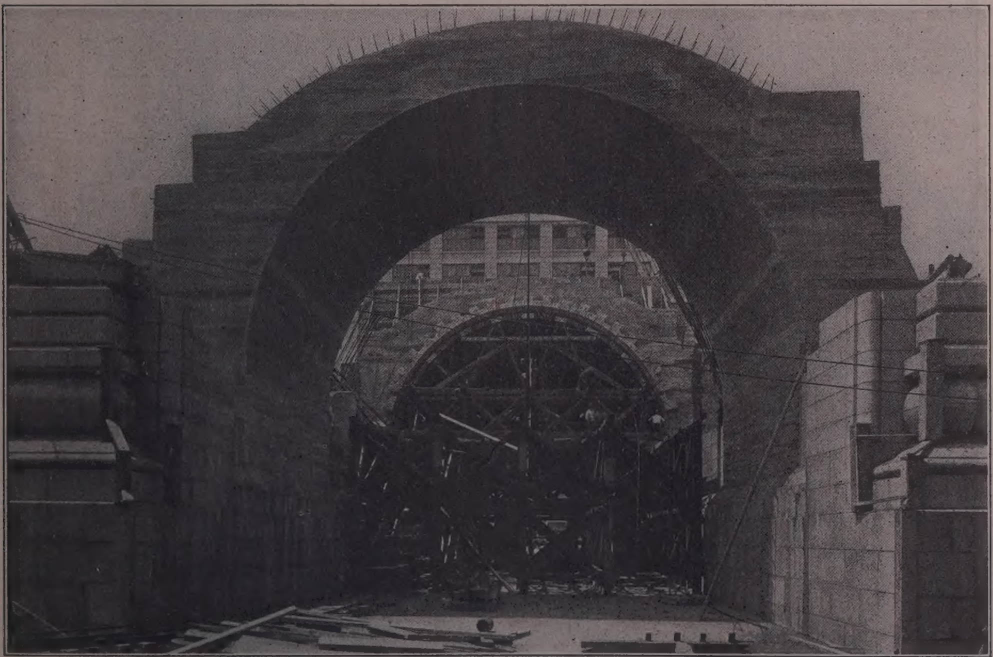
All materials are delivered by boat to the contractors' pier, which extends beyond the main tower of the bridge and is connected with the anchorage by a 36-in. track extending from the outer end of the pier on an elevated trestle work which carries it over the street to the anchorage, around three sides of which it is continued to serve the masonry derricks. The pier front and the dock adjacent to it provide for the simultaneous reception of five or six boats, thus one boat of cut stone, another of cyclopean stone, another of sand, another of broken stone, and another of cement, can be handled at once. The cut stone is received in 400 to 800-ton cargoes, unloaded by the fixed pier derrick, taken ashore on flat cars and stored by derricks on the river front and at the rear of the anchorage. Broken stone and sand are unloaded from barges by a traveling derrick with a clam-shell bucket delivering to a movable hopper placed over a Robbins' conveyor belt on which the continuous discharge is regulated by a shaking device illustrated and described in The Engineering Record for Sept. 9, 1905, where a diagram is given of the general arrangement of tracks and plant. The belt conveyor delivers to a Robbins' bucket elevator, set at a steep incline to the top of the concrete tower nearly 80 ft. above water level, which dumps into hopper bottom storage bins provided with a revolving inclined chute to deflect the stone into the outside divisions of the bin, while the sand falls in the center. The bins have a combined storage capacity of about 180 cu. yd. and deliver by gravity to mixing hoppers on the upper floor of the tower. Cement bags are hoisted by a special derrick to the top of the trestle on which they are stored adjacent to the concrete tower and from which they are taken as required by hand to the mixing hoppers. The mixing is accomplished by a Haines gravity mixer, which delivers directly to 2-yd. cyclopean buckets carried in pairs on flat cars. The plant has a capacity of 600 yd. in 10 hr. and is operated by nine men, including those required for unloading materials from the boats.

Concreting was commenced in September, 1905, and has been handled entirely by two travelers shown in the accompanying photographs, which are located so as to command all parts of the pier. Each traveler consists of a 28x50-ft. horizontal timber platform mounted on twelve wheels and having at each corner a derrick with a 40-ft. vertical mast and a 60-ft. trussed boom of 10 tons capacity, swung by a bull wheel and operated by a double drum Lidgerwood hoisting engine seated on the platform. The travelers were at first installed on timber trestles built up from the bottom of the pit to grade level and handled all stone, concrete, mortar, steel and other materials required for the pier. As the concrete backing was built up, clearance was left around the vertical pieces of the trestle and the braces were removed as necessary. The concrete was built up on one side of the pier to an average height of 10 ft. above the top of the traveler track, the timbers being removed and the wells around them filled with grout and concrete after the masonry reached the rail level. When one-half of the masonry was completed, the traveler which, with its equipment, weighs about 800 tons, was jacked up on cribbing and rolled over on top of the new masonry. The cribbing and falsework was then removed and the new falsework built on the upper part of the concrete and the traveler operated on it until it was necessary to repeat the operation. The traveler had thus been jacked up three times. Each occasion involving a period of about three days' loss of service of the traveler. It was at first intended to build the upper part of the pier with derricks operated from a steel tower afterwards permanently built into the masonry, but the system above described has proved so satisfactory that it will probably be continued for the completion of the work, and the steel towers will not be used.

Work was commenced on the large arch May 1, last, and it is now nearly completed, the voussoirs all being laid, the centers removed at the south end and the concrete backing completed over the stone sections. The intermediate concrete sections were built after the stone sections, and the work was done with the inner booms of the travelers while the outer booms were free for building the face walls or other purposes. Owing to the delay in delivering steel for the anchorage platforms, the construction has been very much delayed, otherwise it is believed that the pier would have already been completed within the specified time of 450 days. The work so far presents a uniform and attractive appearance, and is impressive for the magnitude and the efficiency of the operations. As described in previous articles, all the plant is operated by General-Electric Co.'s motors using a 220-volt current supplied by the Brooklyn Edison Co. This involves a very extensive electric equipment which was installed at the commencement of the work, has given satisfaction to the contractors, and is believed, by them to effect a considerable economy in total cost. The present force consists of about 100 men working single shift and laying from 100 to 400 yd. of masonry daily.



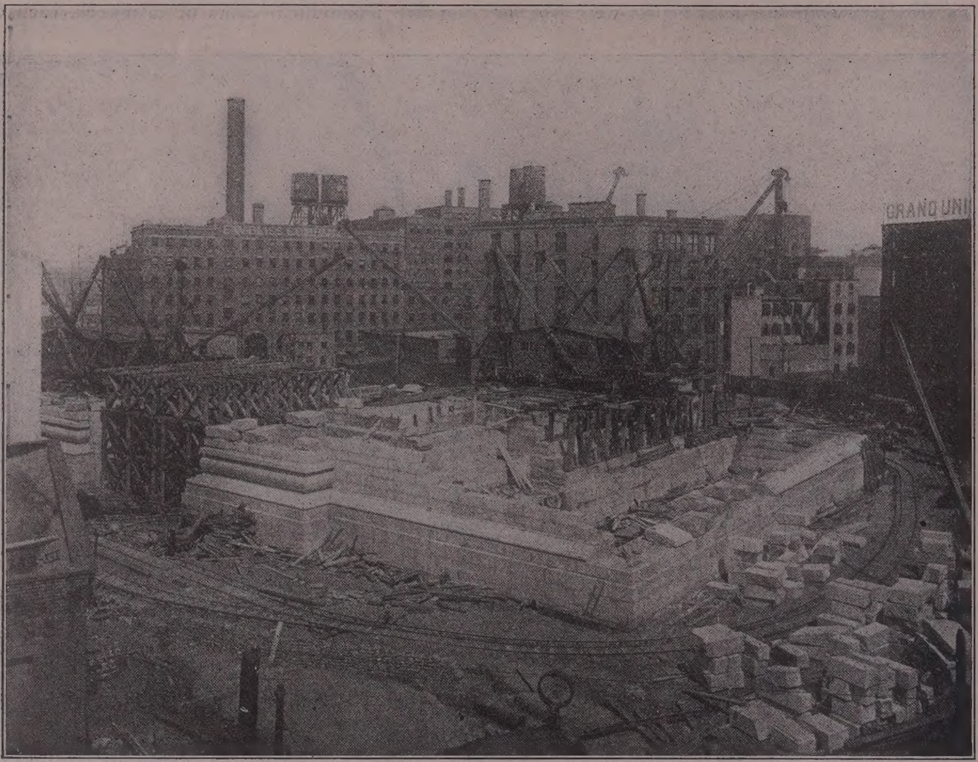
View of Brooklyn Pier under Construction, Showing Traveler.



End Concrete Rib of Main Arch, Brooklyn Pier.

The centering for the large arch is supported on five longitudinal bents of falsework, each of which is made with 8x10-in. vertical posts 5 ft. apart, braced together longitudinally and transversely with 3x8-in. diagonals. The 8x10-in. longitudinal sills have bearing pieces on the concrete sub-base of the roadway. The 8x10-in. longitudinal caps at the top are just below the springing line and support the lower chord of transverse wooden trusses 45 ft. long 10 ft. deep on centers and 5 ft. apart on centers. The top and bottom chords are made with continuous 8x9-in. timbers and the vertical and diagonal members with single 6x9-in. pieces, one of the diagonals in each panel being cut to clear the other and spliced across it with fish plates. At the ends of the trusses nearly vertical scarf boards are secured to form templates for setting the first seven courses of ring stones and the lower part of the concrete, the weight of which is not carried to any extent by the falsework. Above the first seven courses the voussoirs and the concrete are carried on centers made with a horizontal bottom chord divided into four panels, corresponding with the vertical falsework posts.

At each panel point there is a vertical and two diagonals all made with single 6x9-in. timbers supporting at the upper ends scarf boards made with pairs of 3x10-in. plant bolted to their opposite faces. On these planks are secured 5¾x7-in. lagging, one strip of which is laid on the center line of each voussoir of the arch ring, thus leaving a clear space of about 8 in. between each pair of lagging strips and supporting the voussoir at its center point. For the concrete arches the lagging is laid close and receives the concrete directly on the oiled upper surface. The centers are carried from the trusses on pairs of folding wedges at each panel point. The centering and falsework was proportioned for radial loads of 16,000 lb. at the center and 15,000, 10,000 and 4,500 lb. at the successive panel points on each side. These produced stresses of 4,500 to 16,000 lb. in the web members and a maximum of 41,000 lb. in the center vertical post of the falsework. The timber was designed for unit stresses of 9,000 lb. per square inch in tension with the grain, 50 lb. in tension across the grain, 1,200 lb. in compression on end bearing, 900 lb. on columns, 1,000 lb. for extreme fibre stresses in transverse strain and was assumed to have a modulus of elasticity of 1,200,000 lb.

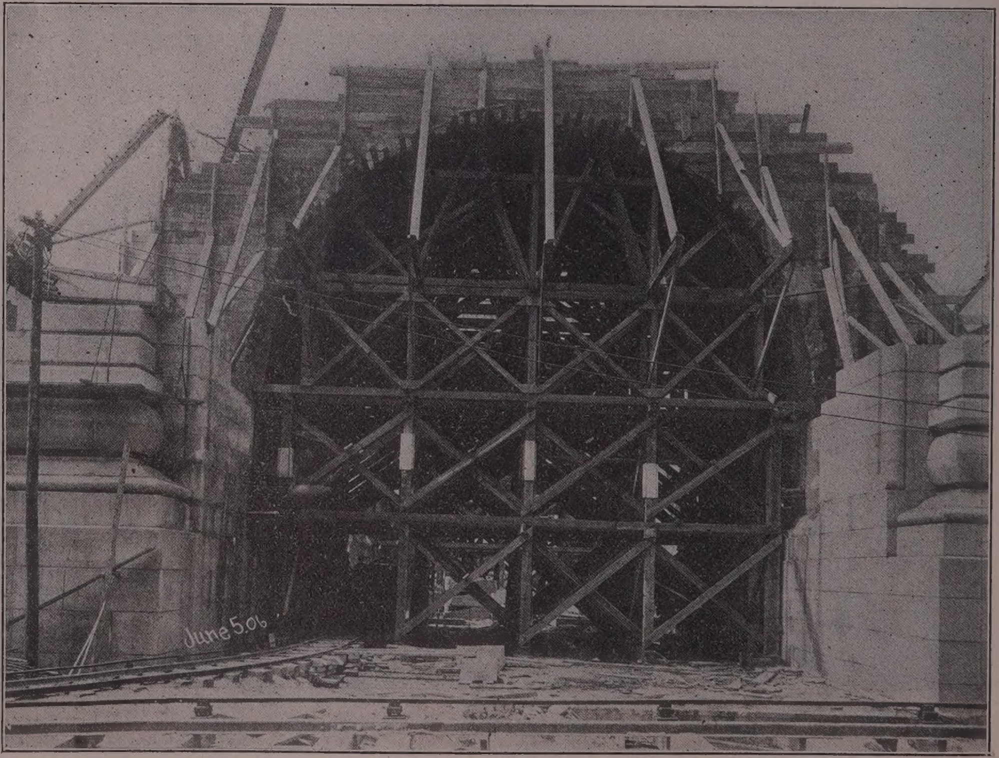


Brooklyn Pier under Construction.

For the concrete sections of the arch, moulds were built in vertical planes with horizontal boards nailed to vertical strips and braced by diagonals to main horizontal longitudinal strips extending through the falsework beyond the face of the arch. The arch was built in successive sections corresponding to the concrete and cut stone construction and the centering was moved from one to another as the work progressed.

The New York anchorage pier is substantially like that on the Brooklyn shore, differing from it chiefly in the depth of excavation, the quantities of materials and the number of foundation piles which on account of softer ground was increased to 4,042. It will contain about 42,260 cu. yd. of concrete, 57,675 yd. of cyclopean masonry and 14,168 yd. of granite facing, of which about 1,250 yd. of cut stone, 19,000 yd. of concrete and 18,500 yd. of cyclopean masonry had been laid Aug. 1. The cut stone is all granite furnished by the Rockport Granite Co., John Pierce Co. and by Mr. John Goss, and quarried at Cape Ann, at Mt. Waldo, and at Stonington, Me. Most of the cyclopean stone is limestone from a quarry in the Catskills, but some of it is granite furnished by the Rockport Granite Co. from the quarries at Rockport, Mass. The $1,197,000 contract for the pier calls for its completion in 450 days, commencing March 1, 1905. Since this contract was awarded the original contract for the superstructure has been cancelled and another one let, thus involving considerable delay in the manufacture of the steel work for the anchorages on account of which, and on account of delay in securing a part of anchorage site, an extension of 120 days was made in the contract. None of the steel for the anchorage platforms has yet been received and until its delivery, the completion of the pier will be still farther delayed.

A very complete and efficient plant for receiving and storing materials, mixing concrete and building the masonry was installed at the commencement of operations and was illustrated and described in The Engineering Record of March 3, 1906. An elevated double track trestle extends from the anchorage pier to the river pier, and on it all materials are delivered by boat. The granite is cut at the quarries, each block is numbered and lettered and the edges are protected by wooden strips secured by steel straps. The blocks are lifted by the pier derrick from the boat to flat cars on which they are taken to storage and piled up until ready for use in the pier. Cyclopean stone is handled in the same way and broken stone and sand are unloaded from the scows by a clam-shell bucket which discharges to a hopper-bottom bin located over a long belt conveyor. The latter delivers the materials from the boat to the storage bins adjacent to the anchorage pier and underneath the trestle. Adjacent to them are the coal bins which are filled in the same manner and nearby is the cement house to which bags of cement are handled either by cars or by the endless belt.



Centering and Falsework for Concrete Arch Rib, Brooklyn Pier.

The stone and sand bins have a combined capacity of over 1,200 cu. yd. and deliver through bottom gates to steel measuring cars. These cars run on a low-level track to a pit located between the bins where they discharge their contents (with the cement added as discharged) into either of two special steel cars that are hauled by a cable up a steep incline at the top of which they reverse, dumping into a cubical mixer. The mixer is revolved and, after a sufficient number of turns, and the addition of the required amount of water, dumps its contents into steel buckets on flat cars at grade. This plant has a nominal capacity of 500 cu. yd. in eight hours, but like most similar installations it is limited by the speed with which the concrete can be removed and placed in the structure.

At the beginning of operations the concrete cars were run directly from the mixer to the different parts of the anchorage on spur tracks; later on these tracks were abandoned and the buckets were handled directly by the derricks, two of which reach the concrete tower and passed the buckets to other derricks on different parts of the pier. As the work progressed, the derricks were required to handle stone and the concrete cars are now pulled a short distance from the foot of the tower by means of a steel cable operated by a hoisting engine nearby. From these cars they are lifted by adjacent derricks and deposited on other cars on the elevated tracks down which they run by gravity around three sides of the anchorage pier and are stopped opposite the derricks which handle the concrete to its destination. This method is not found to be quite as rapid as that of passing the buckets from derrick to derrick, but permits the derricks to be used for other purposes.

The area of the pier is commanded by four guyed derricks with 90-ft. booms of 16 tons capacity and by two stiff leg derricks with shorter booms, one of which is seated near the center of the pier and is easily movable. All of the derrick booms are operated by independent hoisting engines and are swung by bull wheels. The derrick engines as well as the concrete mixer, the hoisting engine in the concrete tower, the belt conveyor and other plant are operated by steam from a 400-h.-p. central plant installed by the contractor. The best record for concreting is two hundred and twenty-one 2⅙-yd. batches in one 12-hr. shift. At the present time about 60 men are employed and are setting the "G" course of face stones at elevation + 25.82, or 13 ft. above grade. A small party of masons lay the face stone in advance and the cyclopean masonry is built up behind to correspond. Three masons have made a record of laying 217 cu. yd. of cut granite face stone in one week. Several more courses of stone must be laid to reach the springing line of the main arch which carries the cross street through the pier.

The design and execution of all work on the Manhattan bridge is under the direction of the bridge department of New York, Mr. James W. Stevenson, commissioner; Mr. C. M. Ingersoll, Jr., chief engineer; Mr. O. F. Nichols, consulting engineer; Mr. H. D. Robinson, engineer in charge. The contractor for the Brooklyn anchorage is the Kosmos Engineering Co., Mr. E. H. Baillee, president, and Mr. Gustave Kaufman, chief engineer. The Brooklyn anchorage work is being done under the direct charge of Mr. D. E. Baxter, assistant engineer of the Department of Bridges. The Williams Engineering & Contracting Co. is the contractor for the Manhattan anchorage, work on which is being executed under the direct charge of Mr. W. R. Bascome, assistant engineer of the Department of Bridges.

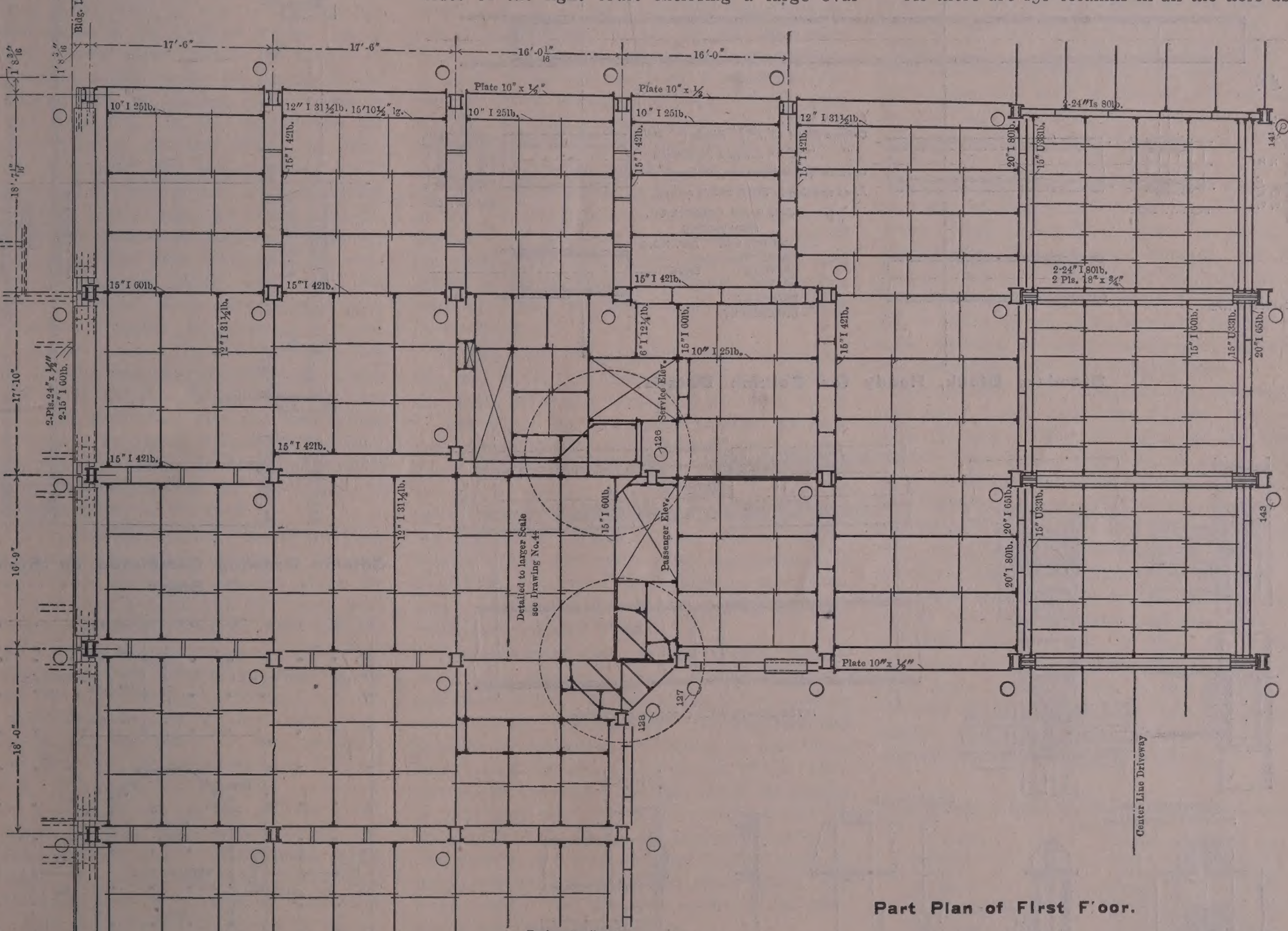
Steel Work in the Apthorpe Apartment House.

The thirteen-story 204x248-ft. Apthorpe apartment house, one of the largest and heaviest buildings of its kind, occupies a full city block bounded by Broadway and West End Ave., and 78th and 79th Sts., New York City. It has a basement and cellar extending about 20 ft. below the curb, while the roof is about 150 ft. above that level. The building is a hollow rectangle enclosing a 150x100-ft. light court, open from the sky to street level and communicating with Broadway and West End Ave. by driveways about 22 ft. wide, which pass through the first story and are continued around the four sides of the light court enclosing a large oval central garden with fountain, flowers and shrubbery. The principal entrances to the building are at the corners of the light court.

The building is of steel cage construction, with 8-in. exterior limestone walls backed up with brick nowhere less than 12 in. in thickness. The court walls are faced with enameled brick. The floors are made with terra cotta arches of about 5 ft. span, with cinder concrete filling and wood surface, except where mosaic is used in public rooms. They are all proportioned for a total dead and live load of 200 lb. per square foot, exclusive of the concentrated loads from partitions made with hollow terra cotta blocks and assumed to weigh 40 lb. per superficial foot, equivalent to about 400 lb. per linear foot. Owing to the great width and weight of the building it is assumed that the wind loads, which will be transmitted throughout the structure through the regular connections, will be resisted by the walls and partitions and will be absorbed by the inertia of the structure, so that no special provision has been made for wind bracing. The heavy static loads have developed large stresses in the columns, the maximum being about 550 tons, which is provided for by a cross section composed of two 15-in., 55-lb. channels, two 14x½-in. web reinforcing plates and two 18x1⅛-in. cover plates. All columns are made with closed rectangular sections built up with channels, cover plates and web plates, and generally proportioned for maximum unit stresses of 11,500 lb. and built with 1-in., ⅞-in. and ¾-in. rivets. At the corner of the driveway and the front wall the columns 137, 141, 240 and 236 sustain very heavy loads, applied on one side through the first floor girders, and in order to provide for the eccentricity of about 2 ft. in its application, the dead and live load stresses are reduced to about 10,000 lb. per square inch.

As there are 156 columns in all the tiers above street level and 192 columns in the tier below street level, and as there are several times as many beams and girders in each of the sixteen tiers, it was especially necessary to adopt a system of marking and construction which would provide for the regular manufacture and delivery of each piece in the sequence of erection, and for its simple and easy identification and location. This was accomplished by the contractor's engineer, who divided the building into five sections, as indicated in the accompanying map, and marked all pieces of the structure to correspond with the section and tier. In section one, the columns are numbered from 100 up, and the beams and girders from 1,000 up. In the other sections the corresponding members are respectively numbered from 200 and 2,000, from 300 and 3,000, 400 and 4,000, 500 and 5,000. Each piece is also lettered A, B, C, and so on, to designate the tier, commencing at the bottom.

The dimensions of the building are so great that complete drawings of the floor plan would be inconveniently large unless made to a smaller scale than is desirable; therefore they also con-

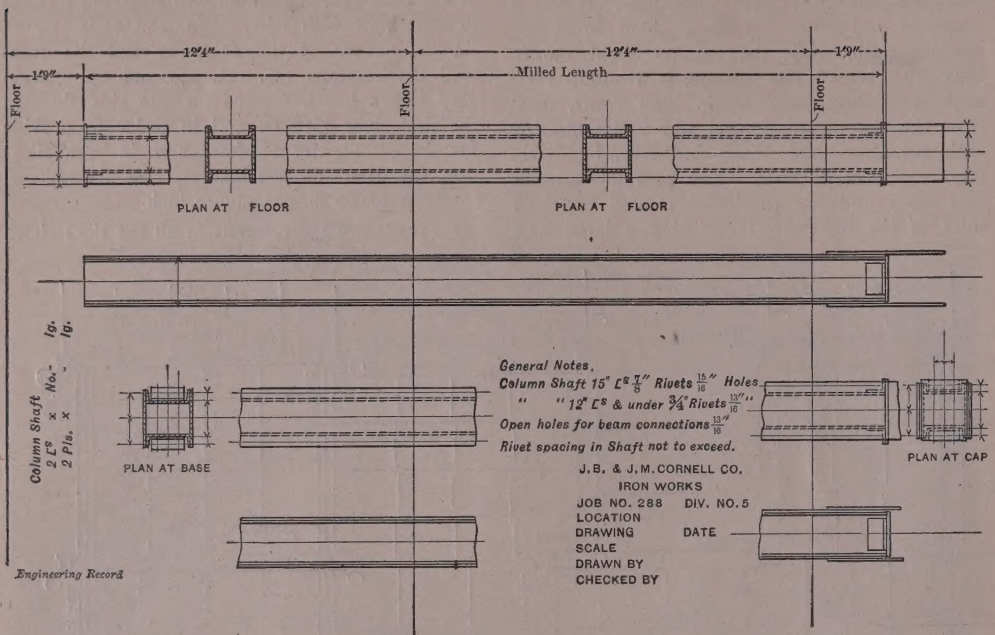


Part Plan of First Floor.

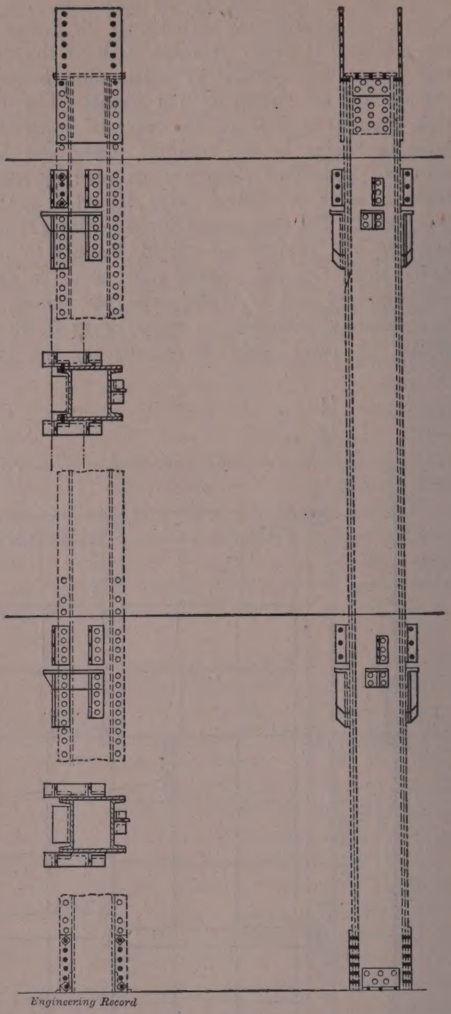
Engineering Record

form to the section map and are made in four or five sheets for each story, and are at a ¼-in. scale, on 36x52-in. sheets. These give as usual the principal dimensions and indicate the members by single center lines with the materials marked on them. Cross sections are taken at various points and the details then drawn to a large scale on the margin of the sheet so as to show the special features of framing, especially in the wall girders which usually consist of one 15-in. I-beam and one 15-in. channel carried on the cantilever ends of the floor girder projecting beyond the faces of the columns. Where the driveway passes through the building at street level it is carried by 15-in., 60-lb. I-beams supported 5 ft. apart by box girders made with pairs of 24-in., 80-lb. I-beams, 23 ft. long, having single 18x¾-in. top and bottom cover plates. This construction, like the floor beams of the light court, supports a heavy concrete slab. Elsewhere the first floor construction corresponds to the section shown and consists essentially of 12-in., 31½-lb. I-beams, from 16 to 17½ ft. long and about 5½ ft. apart, web connected to twin 15-in., 42-lb. I-beams which constitute the floor girders and are symmetrically connected to the opposite faces of the columns except when the alignment of the latter is irregular and makes it necessary to connect one girder to the center of the column and the other girder to the web of the floorbeam so as to offset it from the column. This is the case for columns 110 and 118, and where the girders of the interior panel are at right angles to those of the adjacent exterior panel, and one of the floorbeams in one panel serves as a girder for the floorbeams in the next panel and is centrally connected to the column as at column 117. The beam tiers are special up to the third floor and above that they are essentially regular and correspond in most respects to that of the first floor except as modified in the latter for the driveway, elevators and court entrances, the latter points being quite complicated on account of different levels of connecting beams.

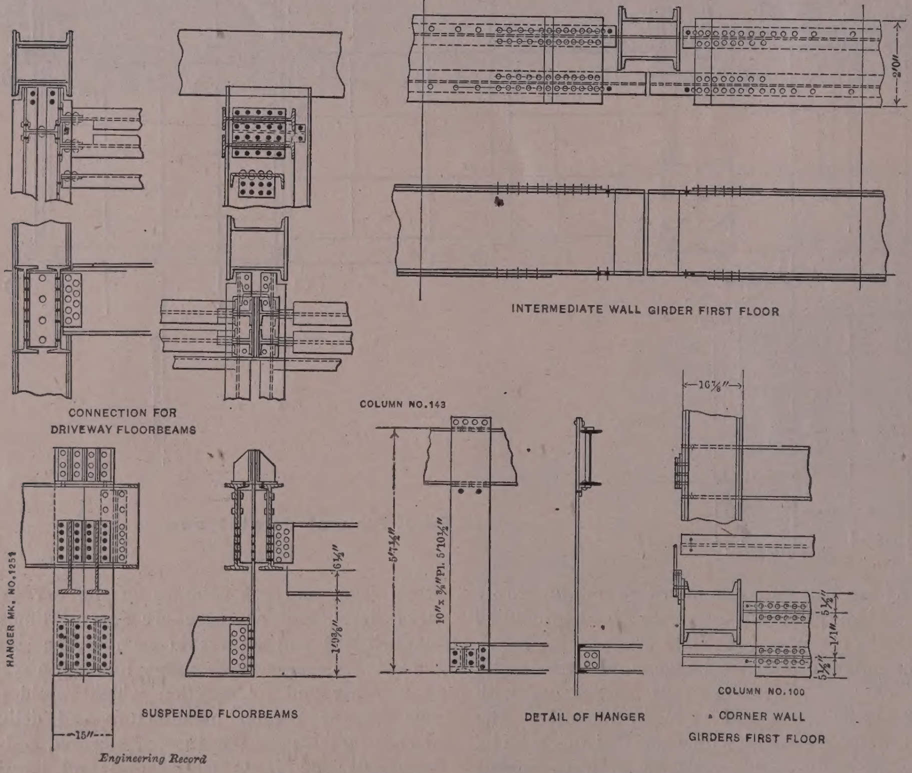
The wall girders in the first story are made special with a pair of 15-in., 60-lb. I-beams and single top and bottom 24-in. flange cover plates ½ or ⅝ in. thick, according to the length of the span. The connections of these wall girders at the corners of the building are indicated by the detail at column 100, where one of the I-beams is shown centrally connected, and the other is carried across one side of the column and supported on it by bracket angles. The connections of the wall girders to the intermedi-



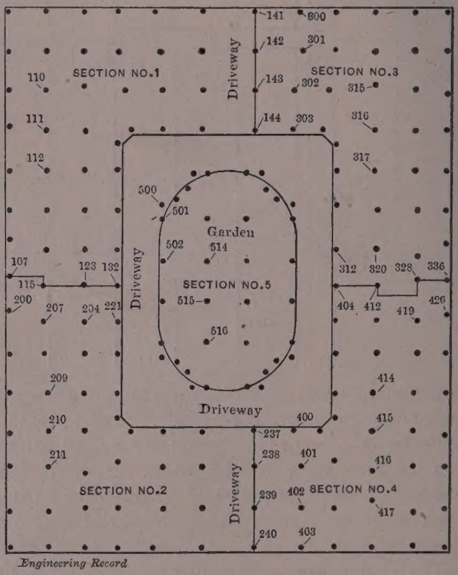
Standard Blank, Ready for Column Details.



Column Drawing Completed on Standard Blank.



Details of Special Connections.



Reference Map

ate wall columns are indicated by the typical detail which shows the inner girders web connected to the column on the center line and the outer girders making a butt joint on the center line of the column. Their lower flanges are seated on horizontal angles riveted to bracket plates on the faces of the columns.

The connections of the beams which carry the driveway floor to the wall girders and produce heavy eccentric column stress before mentioned is indicated by the detail of column 141 which shows the flanges cut to allow clearance for bolting the web connections to the wall girders and their connecting diaphragm.

The difference in the level of the beams under the court entrance requires special provision for supporting them, which in some case is accomplished as shown in the detail of column 143, by riveting a vertical plate between the flanges of the connection angles on the top flanges of the twin I-beams and by framing other beams to them with drop ends. In the regular tiers the web connections of the floor beams are made as much as possible with single 6x6-in. angles shop riveted to the twin girders and field riveted to the beams. This arrangement obviates the necessity of entrance between the twin girders for field riveting, permits wide clearance at the ends of the floor beams and affords ample room for driving the field rivets in the outstanding flanges of the connection angles. In the upper tiers less marked variation occurs, but owing to the fact that the building lines do not make right angles with each other, and that the column centers are not all in the same transverse and longitudinal lines, there is a very great irregularity requiring a large amount of special framing and variable dimensions notwithstanding the uniformity of design and simplicity of the work.

In order to provide most conveniently for these special requirements, certain sections of the general ¼-in. beam plans were selected where the most complication existed, and the areas indicated there by the dotted circles were redrawn to ½ in. scale on separate sheets where the difficult connections were indicated by reference letters and corresponding details showing sections, plans and elevations were grouped about them and drawn to a one-inch scale, thus providing sufficient data for the preparation of all shop drawings. This method is illustrated by the connections at columns 126, 127 and 128 which with their seventeen 1-in. scale details occupy the whole of a 36x40-in. sheet. One of these details at N shows a channel and I-beam suspended from the main floor by a 10x⅜-in. plate about 5½ ft. long, field riveted to it and to connection angles on the flanges of a 15-in. floor beam.

The lower tier of columns has cast-iron pedestals seated on granite cap stones with concrete footings. The columns are all made to conform as nearly as possible with very simple standards adapted to the shop practice followed by the contractors. In general the beams and girders are web connected to short vertical angles, shop riveted to the column webs and cover plates, and have their lower flanges seated on shelf angles or channels with the horizontal flanges of the latter bearing on the milled upper ends of the vertical distributing angles, which when providing for eccentric beams are sometimes riveted to the cantilever projections of bracket plates.

Up to the first tier the irregularity made it necessary to provide special drawings for all of the columns, but above that level the columns are drawn on standard forms like that herewith shown. Each of these forms gives the outline of the shaft together with the principal dimension lines and affords a very regular and convenient foundation to which the specific requirements of the column are very easily and rapidly added. A large sheet of standard column connections has been made which gives all of the principal details for caps, braces, brackets, shelf angles, etc., each indicated by a distinctive reference letter. The detailer writes the sizes of material, rivet spacing, and other general data on the column blank, and then at each point where a standard connection is required, notes that detail A, B, C, and so forth, is to be used here, but does not draw it in.

If special details are required, they can be easily drawn in over the original diagram and thus the complete column drawing is quickly constructed. The blank is made with two side elevations and two front elevations so that it may be used if necessary to give drawings of every face of the column which in that case are designated as A, B, C and D, on the cross sections and correspondingly marked for the elevations. If, as is often the case, the column is symmetrical or nearly so on opposite faces, a separation line may be drawn through the center of the sheet and the two diagrams on one side may serve for one column, and those on the opposite side may serve for a different column. An illustration of the use of these blanks orders fourteen columns in the C-D tier as shown by the accompanying drawing. In this case it happened that all of the details were necessarily special and were drawn in on the blank as indicated by the full lines, the dotted lines being those originally given on the blank.

In most cases these special details do not occur, and in place of them no lines are added to the blank, but a note is made to use detail A, B, C, and so on. By this system rapidity, economy and accuracy are notably promoted, and it is believed that the cost of column drawings on this job will be reduced by it to about one-third of the usual rate. The blanks may be made on tracing cloth by an ordinary tracer, thus saving the detailer's time, and under some circumstances it is possible to make a single drawing and lithograph or engrave it so as to provide a large number of duplicate blanks.

The structural steel in the building weighs about 7,000 tons and will be erected in several successive portions corresponding to the sections shown on the reference map. The members will probably be hoisted and assembled by four boom derricks, one located at each corner of the building, and by two house derricks, one in the middle of each long side. All field connections will be made with rivets driven by pneumatic hammers. The work is now well advanced in the structural shops, erection was commenced about June 1, and it is expected that the steel work will be completely assembled by December 1.

Mr. W. W. Astor is the owner of the building; Clinton & Russell are the architects, and Mr. James Dougan, of their staff, is structural engineer. Mr. John Downey is the general contractor and the structural steel is fabricated and erected by the J. B. & J. M. Cornell Co., Mr. A. E. Roberts, engineer in charge.

Waste Gases from Rotary Cement Kilns are being utilized to raise steam in boilers in a cement plant in southern Germany. The boilers are placed in settings built at the ends of the kilns, eight boilers having been placed in this manner, seven of which are in constant service. The boilers supply steam at 110 lb. pressure to a 450-h.-p. engine which drives the twelve rotary kilns in the plant and a coal grinding plant. The large amount of ash and fine raw materials which are driven off from the kilns is said to occasion the one great difficulty in the utilization of the waste gases, in that the ash and fine material threaten to clog the tubes of the boilers, but this could doubtless be largely overcome if water-tube boilers were used.

The Organization and Equipment of the Office of Public Roads, United States Department of Agriculture.

At this time, when interest in the improvement of public roads is widespread, the work of the National Government in furtherance of this object is attracting particular attention. The act of Congress providing for this work reads as follows: "To enable the Secretary of Agriculture to make inquiries in regard to systems of road management throughout the United States; to furnish expert advice on road building; to make investigations in regard to the best methods of road making, and the best kinds of road-making materials in the several States; to investigate the chemical and physical character of road materials; . . ." For more than ten years Congress has been making small appropriations for the purposes set forth in the bill, but not until the past fiscal year were any steps taken to provide an adequate organization and the facilities necessary to carry out the work.

Prior to July 1, 1905, the field work was under the Office of Public Road Inquiries and the laboratory work under the Division of Tests, the appropriation being entirely separate. On that date the Office of Public Road Inquiries and the Division of Tests were combined to form the Office of Public Roads. The work was divided into three branches, known as information, highways, and laboratory tests and investigations.

No accurate and comprehensive information had, up to a year ago, been collected and compiled showing mileage of improved and unimproved roads in the United States and expenditures of money and labor in their maintenance and improvement. A Chief of Records was appointed and assigned to the work of collecting and compiling such information for every county in the United States. A thorough organization was provided by the appointment of county road correspondents and the work was arranged systematically so that the returns could be issued as rapidly as the figures for each State were available. Up to the present time circulars of information have been issued for a number of States, showing a total mileage and expenditures as indicated in Table I.

Table I.

Total Mileage of Roads and Road Expenditures in Several States.

State.	Mileage.	Exp. in 1904.
Alabama	50,089	$1,576,434.27
Arizona	5,987	109,309.43
Arkansas	36,445	1,395,342.80
Iowa	102,448	3,106,607.50
Maine	25,528	1,472,393.70
Maryland	16,773	873,470.50
New Hampshire	15,116	872,606.35
North Carolina	49,763	1,358,687.23
Oregon	34,258	796,375.97
Tennessee	48,989	1,621,777.15
Virginia	51,812	687,751.06
Washington	31,998	1,436,070.19

The highway work has been placed in charge of a highway engineer who is a graduate of the Massachusetts Institute of Technology and who has had a thorough training in highway work with the city of Boston. There are now three assistant engineers who have risen from the rank of engineer student, and three consulting engineers who are known as authorities on highway engineering in the various sections of the country in which they are located. In addition to these the personnel of the highway division is made up of engineers, expert road builders and expert machinery operators. Object lesson roads are being constructed on the Pacific Coast, in the Southwest, in the Middle West and in the vicinity of Washington, D. C., every part of the country being represented in this work at present with the exception of New England. The field experiments in oil, tar and other special materials is going forward regularly.

The plan of student instruction which was inaugurated a little over a year ago is this year being carried out on a larger scale than heretofore. Six graduates in engineering have recently been appointed to the position of civil engineer student. Under this plan a number of students are appointed each year at $50 per month and expenses while on field duty, the selections being made from an eligible register established by competitive civil service examinations. The students are appointed for a period of one year, the object being to give them graduate instruction in highway engineering, thus aiding in the general work of road improvement throughout the United States by providing competent highway engineers. At the end of the one-year period students may be retained in service and promoted without further examination.

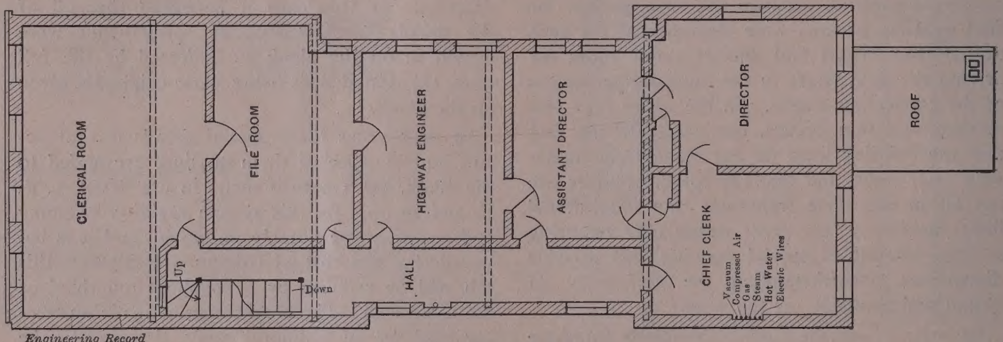
The laboratory work of the office has been increasing at a rapid rate, a comparison of the records showing that the number of samples tested during the past year was nearly fifty per cent. greater than the number tested during the previous year. The significant feature of this work is that a large proportion of the samples tested were received from the New England States, and other States which have received a minimum of assistance in the field work, thereby tending to equalize the benefits which are derived from the work of the office. The investigation work of the laboratory has grown in importance, the research on the decomposition of rock powders having yielded results of a particularly interesting character. The success which has attended the experiments in the mixing of different kinds of rock to increase their cementing value has been most instructive; as an illustration of this, limestone with a cementing value of 20 was mixed with granite with a cementing value of 6, the cementing value of the two combined being 82.

The more important projects taken up by the office may be briefly summarized as follows:

Field Investigation.—The construction of sand-clay roads in parts of the country where no macadam material is available;—Mr. W. L. Spoon.—The construction of burnt-clay roads in parts of the country where only plastic clays are available as road materials;—Messrs. L. W. Page, A. S. Cushman and W. L. Spoon.—Investigations of the use of oil, tar and other bituminous binders for treating the surface of roadways: Messrs. L. W. Page, A. S. Cushman, Vernon M. Peirce, S. C. Lancaster, and Victor W. Dow.—In co-operation with the Forest Service, the extension and construction of roads in the Forest Reserves to facilitate lumbering;—Messrs. L. W. Page and A. E. Loder.—In co-operation with the Post Office Department, improvement of country roads to facilitate the rural free delivery;—Messrs. L. W. Page and Vernon M. Peirce.—Study in regard to the best types of road machinery; Messrs. L. W. Page, Vernon M. Peirce, and J. H. Eldridge.—The field instruction of civil engineer students.

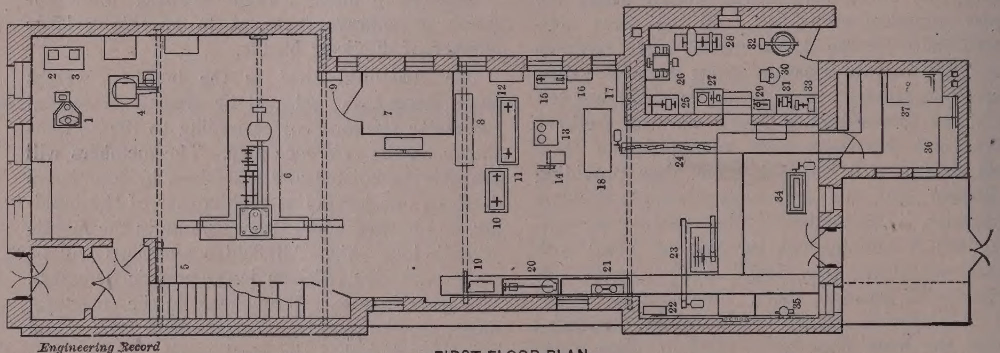
Laboratory Investigations.—Standardization of tests and specifications for paving bricks;—Mr. L. W. Page.—Improvement of test for macadam road materials; Messrs. L. W. Page, A. S. Cushman, and P. L. Wormeley.—Standardization of methods of analysis of asphalts, oils and other bitumens used in road and street construction;—Mr. A. S. Cushman.—Research on the decomposition of rock powder;—Messrs. A. S. Cushman and Prevost Hubbard.—Investigations of clays for the manufacture of paving brick and for burnt clay roads;—Mr. A. S. Cushman.—In co-operation with the Forest Service, the testing of wood blocks for pavements;—Messrs. L. W. Page and P. L. Wormeley.—Investigations of materials for the prevention of dust on roads;—L. W. Page and A. S. Cushman.—Investigation of the constitution of Portland cement and the chemical reactions which take place in the setting of cements;—Mr. Clifford Richardson.—The laboratory instruction of civil engineer students.

Information.—The collection and compilation of road statistics from every county in the United States;—Mr. M. O. Eldridge.—The preparation of a digest of the road laws of the various States and Territories, Philippine Island, Hawaii and Porto Rico;—Mr. J. E. Pennybacker.—The history of the development of road building in the United States;—Mr. Arthur B. Hulbert.—A study of the growth and development of road legislation, and an analysis of the existing laws on the subject;—Mr. J. E. Pennybacker.—Dissemination of information by lectures, addresses and the reading of technical papers.



Engineering Record

SECOND FLOOR PLAN



Engineering Record

FIRST FLOOR PLAN

First and Second Floor Plans, Office of Public Roads Building

Not the least important with reference to the development of this work was the acquisition by the office of an official home. During most of its existence the executive and field work was directed from two rooms on the fourth floor of the main building, while all of the laboratory tests and investigations were made in the basement of an annex some distance away from the main building. In February, 1906, the office moved into a new building which had been erected with special reference to the requirements of this work.

The building is of brick, four stories high, 30 ft. wide by 85 ft. deep, and is situated on the west side of Fourteenth Street southwest, between B and C, a short distance south of the Bureau of Engraving and Printing.

On the first floor, which is of concrete, are located the office of the testing engineer, testing laboratory and the machine shop. This work is under the immediate direction of the testing engineer.

The equipment of the testing laboratory consists of the following apparatus, as indicated on the accompanying first floor plan.

1—Large impact machine for testing paving brick, etc., motor driven; 2—Impact machine for testing the binding power of rock dust, motor driven; 3—Impact machine for testing the toughness of rock, motor driven; 4—Olsen testing machine for tensile, cross-bending and compression tests, capacity 20,000 lb., motor driven; 6—Riehle testing machine for testing tensile, cross-bending and compressive strengths, capacity 200,000 lb., motor driven; 9—Automatic revolution counter connected with testing machines; 10—Speed lathe, driven from a shaft; 11—Engine lathe, driven from a shaft; 13—Drill press, driven from a shaft; 14—Power hack saw, driven from a shaft; 15—Precision lathe, belted to ¼-h.-p. motor; 19—Delicate platform scales; 20—Hydraulic machine for moulding briquettes; 21—Torsion balance; 23—Saw table; 39—Universal trimmer; 24—Abrasion machine for rock testing, geared to ¾-h.-p. motor; 26—6-h.-p. motor belted to shaft; 25—Vacuum pump; 27—Diamond saw and grinding lap; 28—Ball mill for grinding rock samples; 29—Centrifugal pump; 30—Diamond core drill; 31—Rock crusher; 32—Grinding disk for testing the hardness of rock samples; 33—Disc grinder; these last nine are driven from a shaft; 34—Battery of pebble mills geared to ¼-h.-p. motor; 35—Westinghouse air compressor; 36—Hot air bath; 38—Gas furnace, and a complete cement testing outfit, consisting of a Fairbank's torsion machine, Gilmore's needles, standard sieves, briquette molds and so forth.

The numbers shown on the first floor plan and not mentioned in the text refer to furniture and miscellaneous equipment.

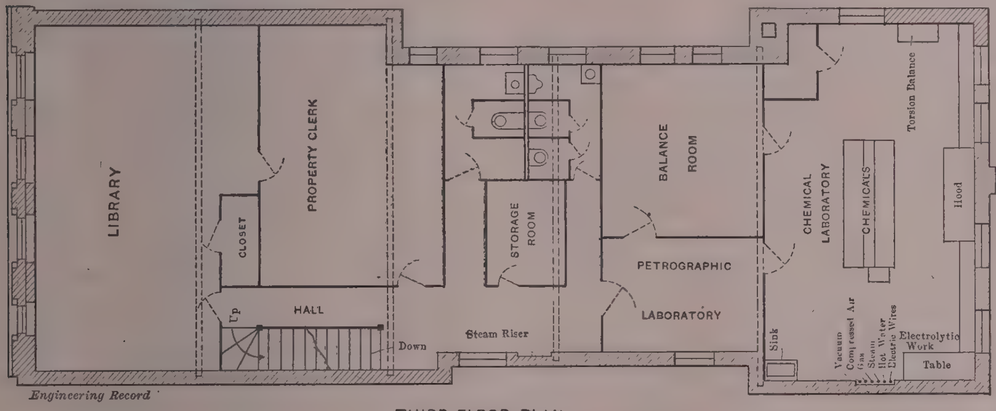
The stairs lead directly from a small vestibule to the second floor, where are located the executive offices, file and correspondence rooms, all intercommunicating and opening into a hall.

A well-equipped library, containing probably the best collection of books and periodicals pertaining to roads extant, occupies the entire third floor front. Seminars are held in the library every Wednesday at 3 o'clock, where road problems and the work of the Office are discussed. Immediately in the rear of the library is located the property room. The chemical laboratory occupies the rear room on this floor, extending across the entire width of the building, a smaller room being used for petrographic work and another as a balance room. The equipment of this laboratory, while not costly, compares, in practical utility, quite favorably with many of the larger laboratories of the country. On this floor are also the toilet rooms and the store rooms.

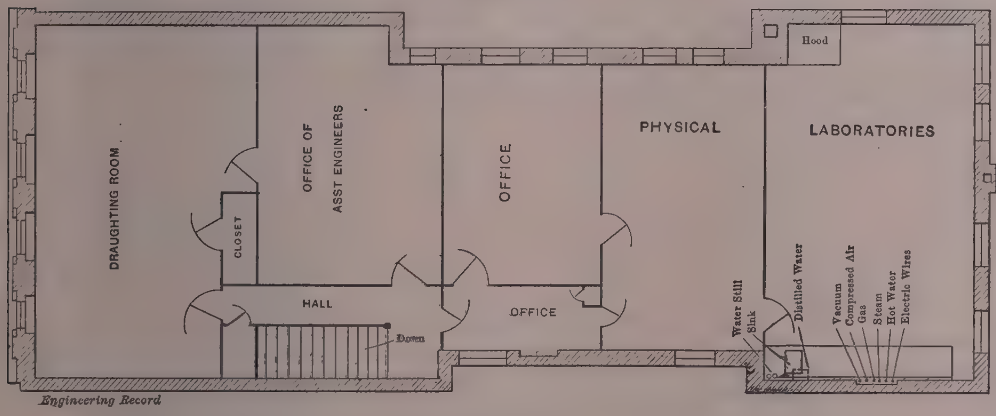
The large front room on the fourth floor is used for drafting and the rooms immediately in the rear are at present assigned to the assistant engineers and experts who are on duty from time to time in Washington. On this floor is also a physicial laboratory.

The Congress just adjourned appropriated $70,000 for continuing the work of the Office of Public Roads during the fiscal year 1907, this being an increase of $20,000 over the past year. The preparations for this year indicate that it is the policy of the Office to work along scientific lines and secure results of a practical nature. The engineer corps is gradually being built up by the appointment of graduates of reputable engineering schools throughout the country, this being one of the requisites for all applicants for examination. Six of these young engineers have just been appointed and are now receiving instruction in laboratory and field work.

A co-operative scheme of the utmost importance in this bearing on the progress of road improvement in this country is that which has just been entered into between the Agricultural Department and the Post Office Department, whereby the engineers of the Office of Public Roads will inspect roads on which rural routes have been or are about to be established and assist in their improvement.



THIRD FLOOR PLAN



FOURTH FLOOR PLAN

Third and Fourth Floor Plans, Office of Public Roads Building.

Another co-operative plan which will shortly be put into effect is one whereby the engineers of the Office of Public Roads will, in co-operation with Forest Service, lay out systems of wagon roads and trails for the various forest reserves.

On the topographic sheets issued by the Geological Survey up to the present time, only public highways and private roads have been indicated, the former by two light lines and the latter by two dotted lines. The Office is co-operating with the Survey to the extent of ascertaining roads that can be traveled at all seasons of the year by an automobile or bicycle, and on the new sheets of the Survey these routes will be indicated by a light and heavy line.

These co-operative schemes in connection with the regular work of the Office as outlined in the projects should bring forth valuable results and add materially to the general progress of road improvement within the next year.

Recent Developments in Wood Block Paving.

Abstract of a paper read before the Municipal Engineers of the City of New York by Mr. F. A. Kummer.

Some problems have complicated the question of wood block pavement in recent years to such an extent that unless these problems could be solved, the use of this type of pavement could hardly be very extensive. These problems were partly of a commercial and partly of a technical nature. They involved, first, the increasing price and the decreasing quality of the long leaf yellow pine, which has been considered the most adaptable wood for such purposes, available for the manufacture of paving blocks; second, the enormous increase, amounting to several hundred per cent., in the cost of rosin. These are both commercial questions, but they brought in their train a very large number of technical questions, the solution of which has not been easy. Ten years ago the average manufacturer of long leaf yellow pine in the South would use every effort to obtain an order for one or two million feet, or more, of all heart long leaf yellow pine, cut from the best part of the tree and of a very superior quality. To-day there is not a lumber manufacturer in the United States, according to Mr. Kummer, who would accept such an order, and only at very high prices can lumber of good quality be secured. It is a well-known fact, for instance, that the density of yellow pine between the lower and upper parts of the tree varies as much as 30 per cent., and yet to-day the lower and larger parts of the tree are being used for large sized timbers, while the smaller and less dense parts are being cut up into paving block or material of a similar small dimension. Then, too, the exclusion of sap wood in the lumber has become and is daily becoming more and more difficult. These conditions would result either in the production of a paving block so costly that it could only be used on the most heavily traveled and luxurious streets, or in the production of a block which would be inferior in quality. Neither of these results were in any way desirable, and it therefore seemed evident that manufacturers of paving block must find a substitute for long leaf yellow pine to avoid these conditions. The United States Government has also taken a very lively interest in this question and through their suggestions as well as through those from other sources, it was concluded that one of the gum woods, existing largely in the South and known as black gum, possessed all the requirements for successful use as a paving material. This wood, on account of the difficulty in preventing it from warping, and other inherent qualities, has been used very slightly for general purposes. It resembles the Australian hard woods that were formerly used abroad for wood block pavements, but while very dense in grain and tough, is not so hard as those woods and not so proof against decay. It was felt, however, that properly treated, it would make a block if anything superior to Georgia pine, and actual tests in service indicate this to be the case. Blocks of this character have been laid for somewhat under a year on Hudson St., New York City, between the tracks of the Metropolitan Street Railway Co. and extending from Dominick to Watts Sts. These blocks are standing up under heavy travel better, if anything, than pine adjoining them in the same location. This wood possesses the great advantage of running uniform throughout and is unlike yellow pine in that it does not have the great distinction and difference in durability between sap and hard wood. In Mr. Kummer's opinion, it will prove a most desirable and valuable addition to the timbers available for paving block purposes.

Returning to the question of the treatment, the advance in the price of rosin from $1.40 to $4.70 per barrel naturally suggested the use of another material, if another could be found equally as good, or a reduction in the amount used, provided this reduction could be made without decreasing the quality of the product. Great difficulty has been found in obtaining any material which will take the place of rosin as a material for waterproofing and hardening the blocks. Asphalts and pitches will not mix with creosote oil, so that their use is in this way prevented, nor have they the advantage of hardening the fiber of the wood. A thorough investigation of the subject led to the conclusion that the only way in which the amount of rosin used could be reduced would be by improving the quality of the oil. Creosote oil is generally tested for its specific gravity and also for its volatizing points. By increasing the specific gravity of the oil called for and greatly reducing the amounts that evaporate at given temperatures, a far heavier, denser and more permanent oil may be secured, and with the use of such an oil, the amount of rosin may be safely cut in half. These statements are not made off hand, but are the result of long and continued experimentation, both as to the possibility of securing thorough treatment with oils of this character, and also chiefly, as to the waterproof qualities of the resulting product, and it has been found that blocks treated with oils of this character containing only 20 to 25 per cent. of rosin, are, if anything, more waterproof than blocks treated with the lighter creosote oils with 50 per cent. of rosin.

These results lead to the very gratifying conclusion that manufacturers of wood block can produce a pavement inferior in no respect to those which have been laid in the past, and if anything, in some respects superior, and which they can safely guarantee under the heaviest travel, without being obliged to ask for such block prices so high as to become prohibitive.

In speaking of these questions, I have not made any reference to the method of treating paving blocks. If this is not well known to all of you, it is sufficient to say that blocks, after being cut to size, are placed in circular cages made of band steel of approximately the diameter of the cylinders in which the treatment takes place, and are then while in these cages run into the cylinders on cars. The cylinders themselves are usually about 6 ft. in diameter and somewhat over 100 ft. long, and are provided with steam coils along the bottom and sides to provide heat for drying and preparing the lumber for treatment. The blocks are heated in this way, some works employing live steam instead of steam coils and others a combination of the two. After several hours both by the use of heat and by the use of a vacuum pump, a large portion of the moisture and light volatile oils in the wood, if the latter contain any such, are driven off. The preservative material is run into the cylinder under a vacuum and hydraulic pressure of 200 lb. per square inch, applied from two to three hours, or for such longer period of time as may be necessary to thoroughly treat the charge, the result being accomplished when the gauges show that no more material is entering the wood.

The question of the proper joints to use between wood paving block is one which has received a good deal of attention. Like many cases of a similar nature it is impossible to generalize and say that any one form of joint is the best for all conditions. On streets where the travel is heavy, the blocks are laid close together and the action of travel tends to expand the head of the block slightly, resulting in the closing up of the joints so that the surface of the street is almost as homogeneous as the surface of an asphalt street, and no crevices for the entrance of water exist. No wood block pavements will be affected by the water which runs over their surface, both because this water quickly flows to the gutter, if the street is properly graded and because the surface of the blocks under travel becomes so dense and hard that they will not absorb water. Where water, however, can run under the block through the joints and remain for many days in the process of being soaked up by the pavement, expansion sometimes takes place, even with the most thorough treatment, this expansion resulting more from the character of the wood than from the character of the treatment itself. It has, therefore, been found that on streets of light travel where the traffic is not sufficiently heavy to cause this unification of the surface, either some form of waterproof joint or else expansion joints to take up any possible expansion of the block, should be provided. In the Borough of Queens, last year, some 50,000 sq. yd. of block were laid on streets of very moderate travel in this way. Half-inch expansion joints were left along the curb and along the rail on streets with car tracks. These joints were filled with paving pitch. Similar joints were placed across the street at intervals of 100 ft. It is very gratifying to note that not only has there been no evidence whatever of any swelling on these streets, but it does not appear that the expansion joint has been brought into play, as according to Mr. Kummer there is no evidence of its squeezing out as would have been the case if the block expanded. This would seem to indicate that its use in this instance was unnecessary, but it is a precaution which Mr. Kummer thinks it wise to take on streets of moderate or light travel.

In some of the Western cities expansion of the pavement, especially where blocks of light treatment are used, is prevented by grouting the whole surface with a paving pitch joint. This absolutely prevents the entrance of moisture into the pavement, but is open to a defect so serious that its use in this way is very limited. In spreading melted and hot paving pitch over the surface of a street and brushing it into the joints with squeeges, a certain amount is left on the surface, and under the action of the hot sun this becomes very sticky and disagreeable. In the nature of things is would be used generally on residence streets, as these streets usually have moderate travel. If used on these streets the results would be very unsatisfactory to the property owners because as soon as the pitch gets sticky, it is tracked on the sidewalks and into stores and dwellings. In the city of Baltimore some contracts have just been let in which an attempt will be made to pour the joints with paving pitch instead of spreading the pitch over the surface, but unless the blocks are separated so that the spout of the can from which the pitch is poured can be run along the groove, Mr. Kummer says his experience is that very few, if any, workmen can accurately pour joints of this character without getting more pitch on the surface than they do into the joints.

If the pitch is spread over the surface in very hot weather and the greatest care is taken, not only to leave as little as possible on the surface when sweeping it into the joints, but also to put sand over the surface of the street while the pitch is hot, this surface pitch will be ground off by the action of travel within a reasonably short time, but even during that period the complaints from its use will be very humerous. Still another consideration arises in the case of these joints which may not be apparent at first thought. On prominent business streets in large cities, if the joints are to be made with sand, it is not practical to leave a coating of sand on the street long enough for it to work into the joints by the action of travel. This results from the fact that this sand is constantly being blown into the faces of pedestrians and into stores and office buildings to the great dissatisfaction of the public. A cement joint, inasmuch as it is run between the blocks in the usual manner, is very quickly applied, and the surface of the street may be swept clean of the sand top dressing within a short time. In fact, under these circumstances there seems very little necessity of using much, if any, sand top dressing at all, except for the purpose of filling up those few joints which the grout has not thoroughly filled.

In the beginning of the wood block industry in the East, blocks of uniform lengths of 8 in. were called for and have been called for for the past five or six years. The Western practice, on the contrary, has in many instances admitted blocks running in lengths from 6 to 10 or even 12 in. Mr. Kummer is inclined to believe that this provision is a very wise one, inasmuch as the length of the block has no direct relation to its wearing qualities, and it is possible to more readily obtain a lumber supply with planks ranging, say, from 6 to 10 in. in width, than by being obliged to buy all planks of the one width. As far as the depth of the block is concerned, he believes that blocks 3½ in. in depth, of proper material and properly treated, will be quite as serviceable as 4-in. blocks, as the rate of wear is very small, and either would probably become unserviceable after one of two inches of the surface had worn off, but this amount of wear would not occur in a very long period of time. For decreasing the cost of the pavement on less important streets, 3-in. blocks have been very successfully used; but there are mechanical objections to using blocks of less depth than 3 in., as they have not sufficient depth to bind them properly in the street.

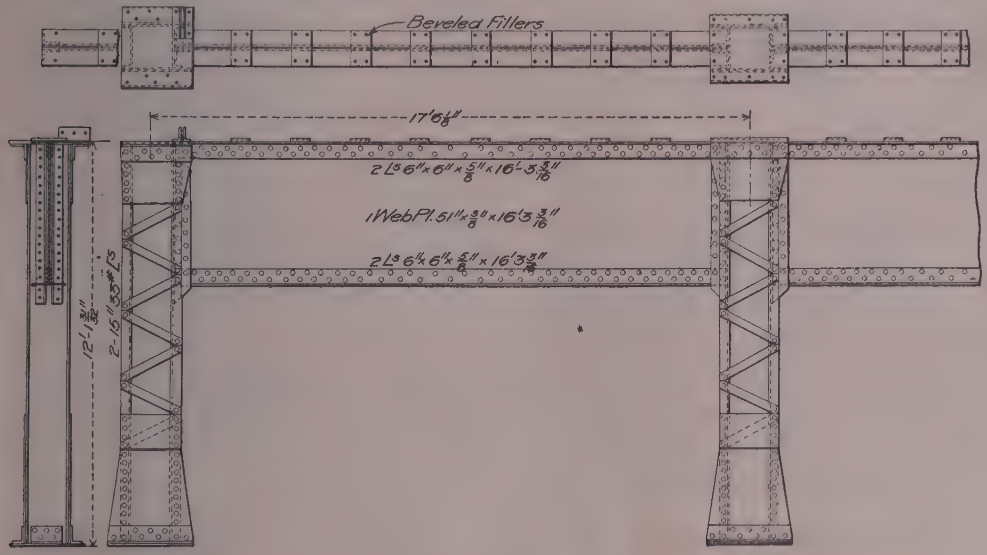
It has been thought by many people in the past that the constant sprinkling of wood block streets is to their advantage. It has been Mr. Kummer's observation that such sprinkling is a very great disadvantage and greatly reduces the resistance of wood block pavements to wear, the reason for which he considers very evident. If the surface of the street is kept constantly wet and then pounded by heavy travel, the upper fibers of the wood are softened in just the same way that any other similar material, even stone, is more easily worn away when wet than when dry. Tests made by the United States Government, Bureau of Forestry, on the relative resistance of wood to breaking, crushing, etc., when wet and dry, show differences extending in some cases up to 100 per cent., and the presence of moisture in the fibers of wood block will cause it to wear out much more rapidly than if kept dry. Warren St., New York, the first street laid in Manhattan with wood block, with the exception of 20th St., originally laid some ten years ago with Australian hard wood, was for a long period after it was laid kept continually wet under a private sprinkling contract. Last year this sprinkling was stopped. Mr. Kummer made a careful examination of blocks taken from this street and found in many cases the tops of the blocks instead of being pounded down and dense and hard, as is the case on streets not so sprinkled, had broomed out under the action of travel and the preservative material mechanically pounded out of the wood by the combined action of the travel and the water. This, of course, leaves the surface of the block unprotected by the antiseptic preservative and ready to decay. It also, in its spongy condition, offers poor resistance to wear. For this reason it would seem very desirable, Mr. Kummer says, that wood block streets should be sprinkled only so much as is necessary to sweep their surface properly, and should be kept clean and free from dust rather than to depend upon the old-fashioned plan of converting the dust into mud by putting water on it. There is no difficulty in keeping wood block streets clean, because unlike asphalt streets the wear upon them does not produce a fine dust and unlike granite block streets there are no large joints or crevices to hold dirt.

The mortar bed as a substitute for the sand cushion, used abroad extensively, and first suggested in New York City by Mr. Geo. W. Tillson, chief engineer of the bureau of highways of the Borough of Brooklyn, has proved in every way a decided advance over the sand cushion. It will not hold moisture to any appreciable extent and it cannot shift and always maintains the block in a rigid position. Wood block, being in itself, elastic, requires no cushion, as would be the case with stone or brick, but while wood block pavements have a very long life, if the individual blocks which compose the street are kept perfectly to grade, it is one of the most easily destroyed pavements in the world if the surface becomes uneven, and this can never be entirely prevented where a sand cushion is used.

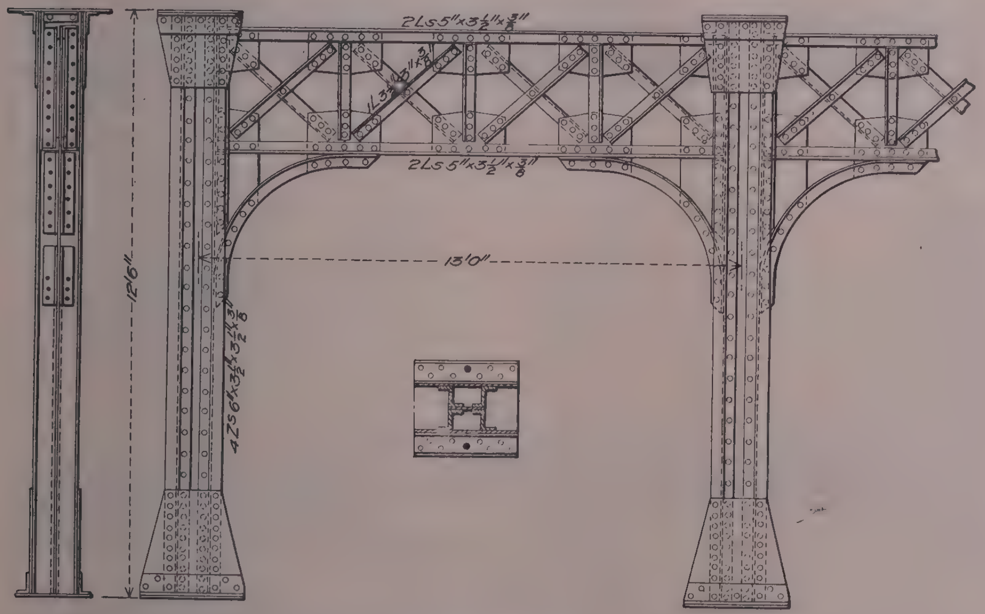
Rapid Reconstruction of a Brick Chimney that had been struck by lightning and badly damaged, was recently made at Elizabeth, N. J. The chimney was 90 ft. high, of radial brick construction, square at the base and the upper 65 ft. of circular section, capped at the top with a cast-iron ring. The lightning struck this ring, splitting it, and tore out a jagged hole from one side about 40 ft. down from the top, thus putting the plant entirely out of commission. The upper portion of the stack was quickly torn down and, five days after the damage occurred, the brick arrived and reconstruction began. In three days more the work was completed, steam raised in the boilers, and the plant, the Colwell Lead Co., resumed operation. The stack was struck July 4, and reconstruction completed July 13, the total loss of time being thus but seven days.

Bridges on the 40th St. Line of the Chicago Junction Ry.

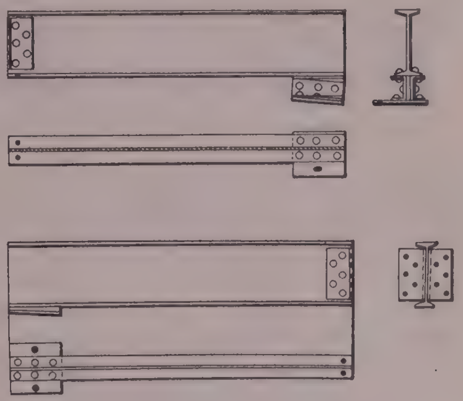
The tracks of the 40th St. line of the Chicago Junction Ry. cross Wabash Ave., Chicago, on a through plate-girder bridge 100 ft. long and 39 ft. wide, which is supported by the masonry abutments on both sides of the street and by two bents of vertical columns at the curbs 54 ft. apart. In this case the grade does not provide sufficient depth for a ballasted floor and the rails are laid directly on a continuous flat plate riveted to the top flanges of the floor beams spaced close together so as to form one of the typical forms of shallow floor used for the track elevation on this line.


Beveled Fillers
17'6⅛"
2 L^s 6"x6"x⅝"x16'-3 3/16"
1 Web Pl. 51"x⅜"x16'3 3/16"
2 L^s 6"x6"x⅝"x16'3 3/16"
12'-1 31/32"
2-15" 33# [s

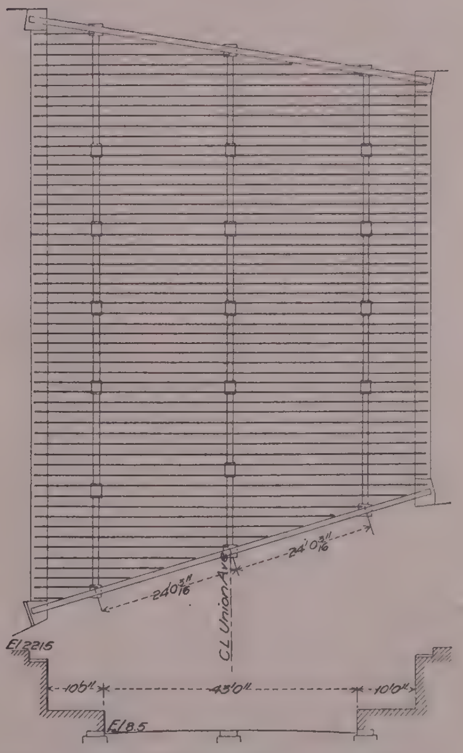
Transverse Girders and Columns.



Column Bracing.



End Beams.

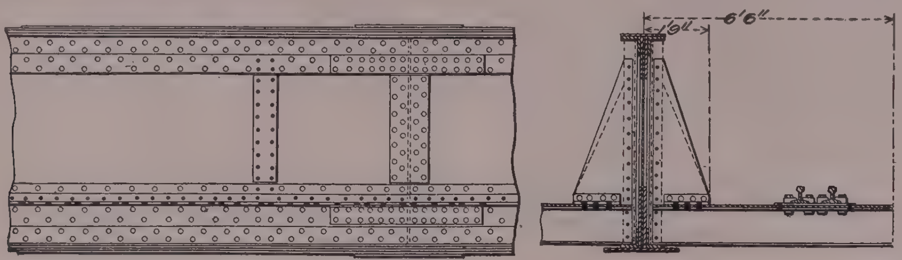


Plan of Longitudinal Beams and Transverse Girders.

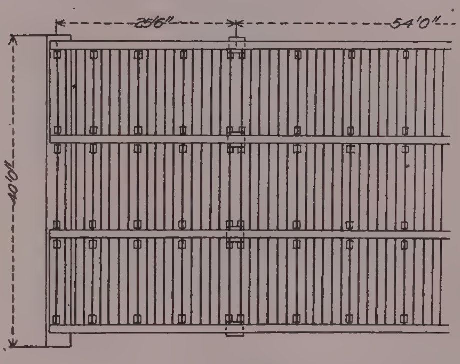
Each bent has four columns 13 ft. apart on centers connected by latticed girders, transverse struts and curved knee-braces, giving a portal effect. The girders have sole plates somewhat wider than their bottom flanges, which are beveled to correspond with the grade and are riveted to the cap plates of the vertical posts. The girders have a uniform depth of 66 in. except at the ends of the bridge, where the top flanges are curved to a 17-ft. radius, reducing the height to 4 ft. In the main span the web plates are made in two pieces, spliced at the center with a pair of vertical cover plates and two pairs of narrow horizontal flange plates. The top flange of the center girder is made of a pair of 12x½-in. vertical plates, a pair of 6x6x½-in. flange angles, and one 14x9/16-in. cover plate, all full-length, unspliced pieces. There are also three additional 14x½-in. cover plates 35 ft. 3 in., 29 ft., and 20 ft. 3 in. in length. The bottom flange differs from the top flange on account of the provision made for connection to the 12-in., 45-lb., transverse I-beams 15 in. apart on centers. It consists of two 19½x½-in. vertical side plates, two 6x6x½-in. angles and one 20x9/16-in. cover plate, all single full-length pieces, and one 14x½-in. 29-ft., and one 14x¼-in. 20-ft. 3-in. cover plate. The first cover plate projects 3 in. beyond each edge of the flange angles and of the outer cover plates, and is attached to the bottom flanges of the floorbeams with two rivets in each beam. The top flanges of the floor beams are riveted to the long flange of a 5x3½-⅜-in. horizontal angle field-riveted through the vertical side plates to the web of the girder. The floorbeams are thus supported entirely by the lower flanges of the girders except at panel points 7½ ft. apart, where they are riveted to gusset plates extending to the top flanges of the girders. The ends of the floorbeams are seated on the horizontal legs of the lower-flange angles, where alternate rivets are countersunk to clear them. They are not riveted to the flange angles, but have field rivets through fillers and the edges of the wide cover plates.

The abutment masonry is not built as high as the tops of the columns, and the girders are carried 20 in. above the top of the masonry on transverse girders which serve as pedestals and also act as cantilevers supporting the outside girders nearer the edge of the masonry than could be safely done with direct bearings. These pedestal girders are made of pairs of 18-in., 55-lb. I-beams with their flanges connected by base plates to bear on the masonry, and by cap plates to receive the girder bearings. The webs are stiffened with pairs of 3½-in. angles fitted to the flanges. The floor in this bridge weighs 53 lb. per square foot. The total weight of the structure is 437,200 lb., including 218,000 lb. for the floor.

At crossings where it is permitted to locate one row of columns on the center line of the street and one on each of the curb lines, the bridges are made with transverse girders, web-connected to the columns and supporting on their top flanges lines of longitudinal I-beams 20½ in. apart on centers, as shown in the part cross-section of the Union Ave. bridge. This bridge is special on account of its trapezoidal plan, which necessitated different details for the floorbeams at the sides of the bridge. At one side the ends are web-connected with bent plates to an oblique fascia girder 3 ft. deep. At the other side, short vertical transverse diaphragms are web-connected to the fascia girders and to the next full-length longitudinal beam, and one end of the short longitudinal beam is web-connected to this diaphragm at right angles. The I-beams over the sidewalks are web-connected at one end to the I-beams spanning the road and at the other end have riveted to the lower flanges shoes made of double pairs of angles inclined to correspond with the grade. This floor weighs 42½ lb. per square foot of the area included between the center lines of the outside girders. The total weight of the structure is 363,500 lb., including 114,900 lb. for columns, fascia and transverse girders.



Through Span Girder and Floor Beam.



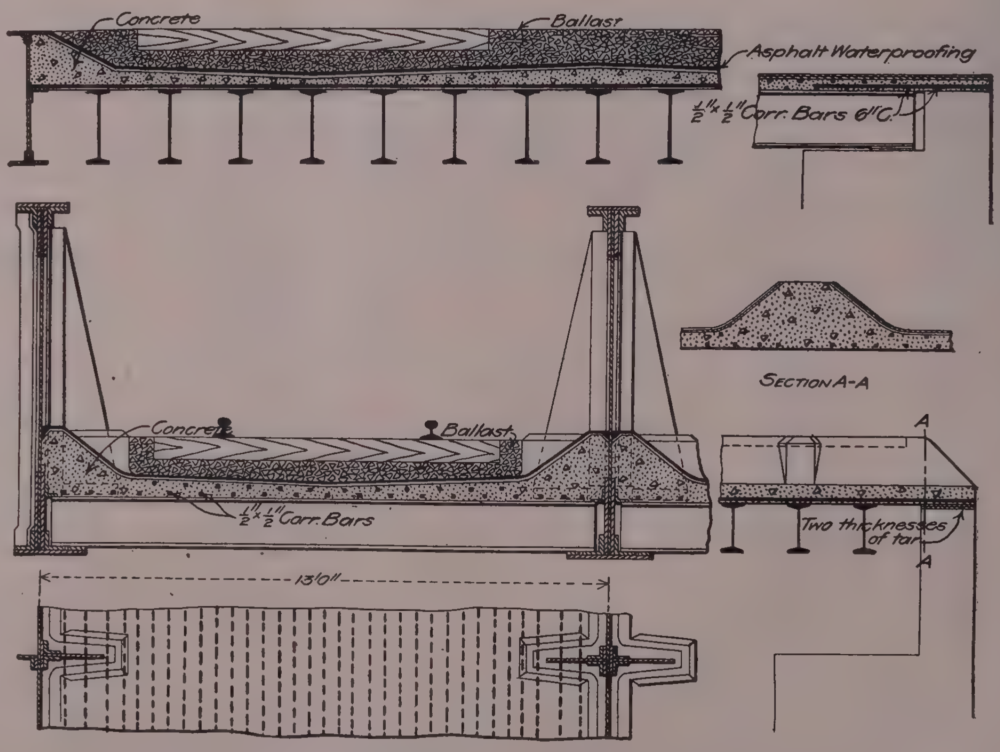
Plan of Longitudinal Girders and Transverse Beams.

Where columns are not allowed in the centers of 66-ft. streets, it is found that there is no economy in using columns on the curb lines, and these crossings are made with single full-length through girders spanning both the roadway and sidewalks and having a floor which weighs about 27 lb. per square foot in the three-track Dearborn St. crossing, which has a total weight of 261,200 lb., including the 75,000-lb. floor.

On some of the 40th St. track elevation the ballasted floor has been made with transverse I-beams covered with 2⅝-in. longitudinal splined boards essentially corresponding to the shallow floors in use on the Chicago & Western Indiana Ry., and the joint track elevation since 1901. For the joint track elevation work the 12-in. I-beams weigh from 40 to 55 lb., and are spaced from 13 to 16 in. on centers. These give a metal weight of 600 lb. per linear foot of single track. For the Chicago & Western Indiana work the 15-in., 45-lb. I-beams are spaced 18 in. apart and, together with their braces, weigh 440 lb. per linear foot of single track. In both cases the edges of the wooden floor are sloped upwards and supported on wedge-shaped pieces that carry them above the longitudinal angles riveted to the girder webs.

Under date of May 28, 1906, Mr. W. M. Hughes writes: "Since these plans were sent to you we have decided to put in reinforced concrete floors where ballast is used. This floor will be waterproofed with asphalt. The Chicago & Western Indiana adopted this plan and it has proved quite successful. The shallow floor without ballast has been almost entirely abandoned by most of the roads here for track elevation work, and wherever columns are allowed in the center of the street deck structures similar to that at Union Ave. are the more desirable on account of no interference with cross overs and turnouts. In this 40th St. work there are a total of 29 street and alley crossings amounting in the aggregate to about 5,300 tons. These structures were all designed for a live load of 5,000 lb. per linear foot of track plus 50,000 lb. concentrated."

The design has just been completed for the reinforced concrete floor referred to by Mr. Hughes. It consists of a continuous floor slab supported on the top flanges of the floorbeams and is of two types, corresponding to the transverse and longitudinal arrangements of the latter. One type is used with transverse floorbeams and consists of a slab between each pair of girders with its upper surface pitched from both the longitudinal edges to a gutter under the center of the track where its thickness varies from 3½ to 5 in. At the edge the concrete is thick enough to reach just above the rail base, and thence slopes at an angle of about 45 deg. to the edge of the gusset plates where the normal slab has a thickness of 4½ to 6½ in. A small triangular depression is made in the upper surfact of the concrete adjacent to the girder web to retain asphalt, with which the joint is sealed to prevent percolation of water along the face of the steel. The remainder of the concrete surface is covered with asphalt waterproofing and on it is laid stone ballast about 6 in. thick under the ties. The 1:2:4 Portland cement concrete is reinforced with ½-in. corrugated bars in staggered rows near the upper and lower surfaces. Care is taken to mould the concrete symmetrically around the bases of the gusset plates and at the abutments. The concrete slab extends 2 or 3 ft. beyond the last floorbeam and takes bearing on the back wall with double thickness of tarred felt.



Standard Floors with Longitudinal and with Transverse I-Beams.

Where the floorbeams are longitudinal the floor slab has the same general outline in cross-section as already described, except that on the outer edges the upper surface of the concrete is sloped up flush with the top flange of the fascia girders and there are no gusset plates to interrupt its continuity. Here also the reinforcement rods are transverse instead of longitudinal, but are located, spaced and staggered in substantially the same way. At the end of the span where the concrete slab projects beyond the ends of the floorbeams to rest on the back wall of the abutment, the cantilever portion is reinforced by short longitudinal bars.

In this connection it is interesting to note the types of solid floor that have been used for Chicago track elevation during the last few years. That adopted by the Pittsburg, Fort Wayne & Chicago R. R. in 1897 has transverse rectangular troughs made entirely of plates and angles forming a zigzag line in cross section. It weighs 830 lb. per linear foot of track and is field-riveted with web-connection angles to wide vertical plates in the flanges of the main girders. The girders are braced by gusset plates stiffened with inclined angles and connected by bent plates to the summit of every fourth trough.

The type used by the Chicago, Milwaukee & St. Paul Ry. in 1899 has 12-in., 45-lb., transverse I-beams 15 in. apart, which rest on the lower flanges of the main girders and are covered by continuous flat deck-plates 5/16 in. thick, over which there is laid under each rail a line of 10-in. channels and an 8½x¼-in. bearing plate. This floor weighs 820 lb. per linear foot of single track.

The shallow floor used by the Chicago, Burling & Quincy R. R. in 1900, has 12-in., 45-lb., transverse I-beams 14½ in. apart on centers, which are seated on the angles of the regular T-shaped bottom flanges of the main girders and are connected to the latter by pairs of vertical angles shop riveted to the girder webs and bolted to the floorbeams. The beams are covered with 5/16-in. deck plates, above which there is a trough for each rail, consisting of a 20x½-in. plate, two 5½x3½x½-in. angles and 2x3x5/16-in. outside angles. The rails are laid in these troughs on insulation ⅛ in. thick. Every sixth beam has gusset-plate connctions to the main girders. The floor weighs 870 lb. per linear foot of track.

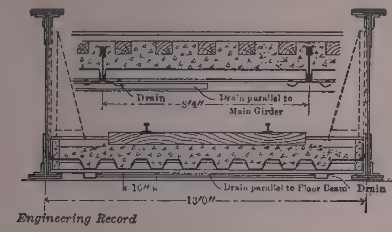
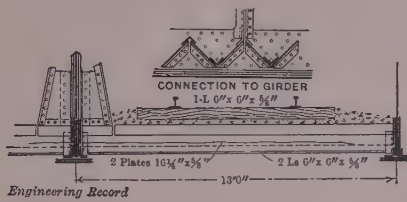
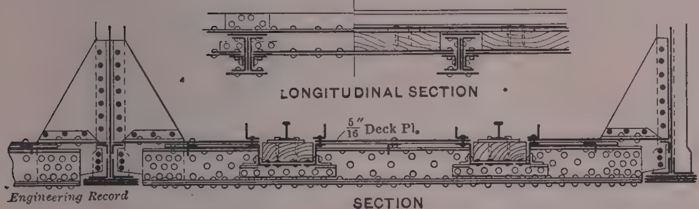


Plate Girder Floor Beams and Longitudinal Floor Troughs.

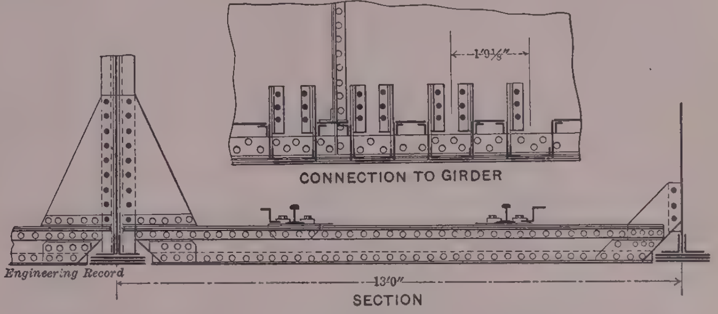
The Chicago, Rock Island & Pacific Ry standard of 1900 also has a plate-and-beam floor, but differs materially from the others in the connections of the beams to the main girders. The floor plates are ⅜ in. thick and the 12-in., 45-lb. beams are 15 11/16 in. apart; their ends are beveled and have inclined connection angles riveted to them and to bent plates field-riveted to the girder webs through the vertical flange plates and through horizontal angles on top of the deck plates. The first cover plate in the girder flange is special, projecting beyond the edges of the outside cover plates and bent downwards to engage the ends of the floorbeams. The rails are laid on 16¼x⅜-in. rail plates with 6x4½-in. angles on the outsides only. Every fourth floorbeam is braced to the girders by gusset plates with their lower corners cut to clear the longitudinal angles on the webs. This floor construction weighs 890 lb. per linear foot of track and was designed for a 50,000-lb. axle load plus 25 per cent. for impact, each floorbeam being proportioned to carry one-third of this amount with maximum unit stresses of 10,900 lb.



Pittsburg, Ft. Wayne & Chicago Railroad Standard.

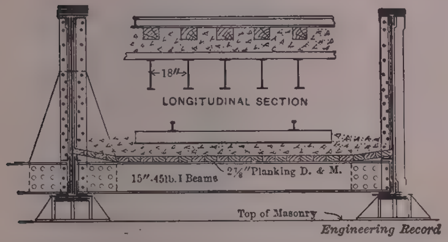


Chicago & Northwestern Ry. Standard, 1899.

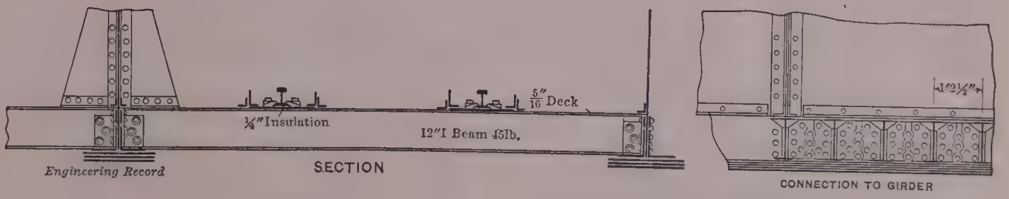


Chicago, Rock Island and Pacific Ry. Standard of 1897.

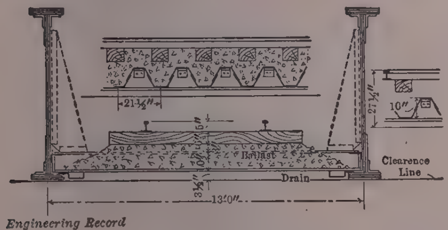
The Chicago, Rock Island & Pacific type of 1897 has rectangular transverse floor troughs made of 9½x⅜-in. vertical plates, 9⅞x7/16-in. top plates, 11⅞x7/16-in. bottom plates, and 3x3x⅜-in. angles. The ends are beveled to clear the flange cover plates of the girders, and they are connected to the girder webs by oblique 10x7/16-in. plates field-riveted to the trough webs and to the girder webs. The girders are knee-braced to every third trough by deep gusset plates, connected to the top plate of the trough independently of the regular trough connections to the girder. The rails are seated on continuous 18x½-in. track plates, each provided with a single 5x3½x½-in. outside Z-bar acting as a guard rail. The weight of the floor is 875 lb. per foot of single track.



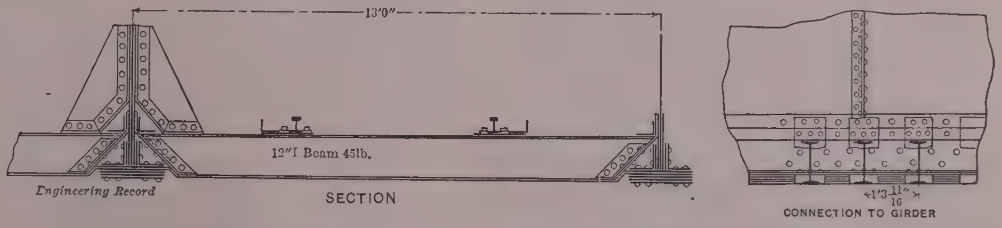
Chicago & Western Indiana R. R. Standard.



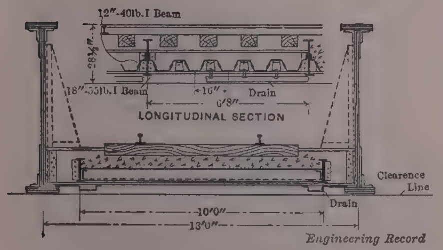
Chicago, Burlington & Quincy Railroad Standard.



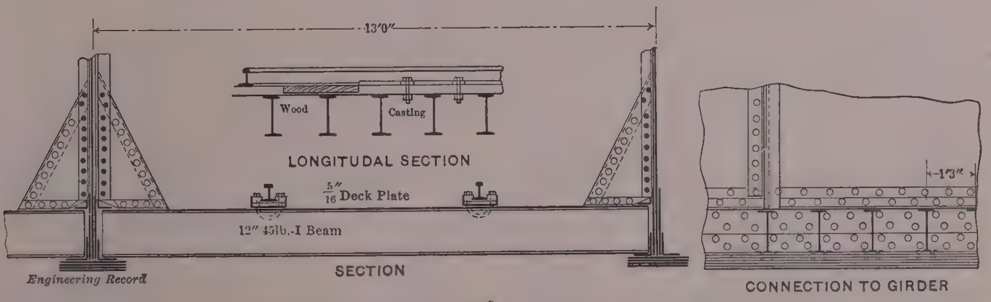
U-Plate Floor.



Chicago, Rock Island & Pacific Ry. Standard of 1900.



U-Plate and Stringer Floor.

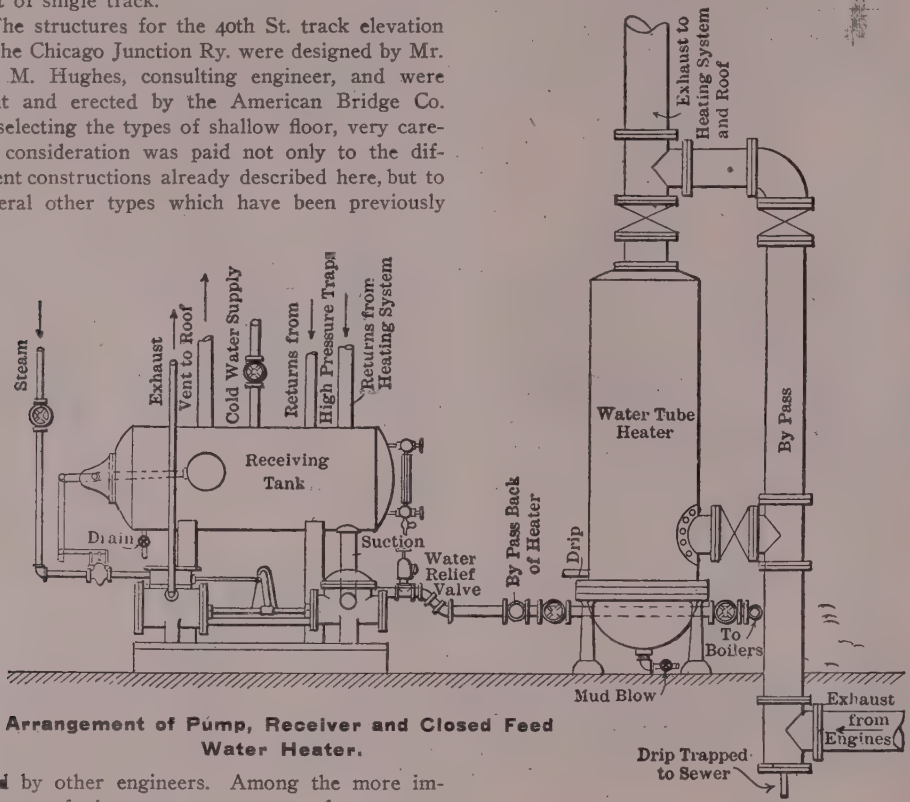


Chicago, Milwaukee & St. Paul Ry. Standard.

In 1899 a shallow floor made with 15-in. transverse I-beams 15⅞ in. apart on centers was substituted for the above type by this road for the track elevation. The connections of the I-beams to the girders were of a special character, designed to bring the lower flange of the I-beam flush with the lowest point of the girder flange and thus reduce to the utmost the depth of the floor. The lower corners of the I-beams were beveled to clear the girder flanges, and to their webs were shop-riveted inclined connection angles with bent plates field-riveted at the lower ends to corresponding continuous bent plates on the girder flanges and at their upper ends field-riveted directly through the girder webs. The girders were knee-braced to every fifth beam with gusset plates. The top flanges of the I-beams were covered with a continuous 5/16-in. flat deck plate, on which was laid a continuous 18x7/16-in. track plate under each rail. Insulation was provided between the rail and the plate, and on the outside edge of the latter a single 6x4x⅝-in. angle was riveted. The floor weighed 886 lb. per foot of single track.

The shallow floor used by the Chicago & Northwestern Ry. for track elevation in 1899 is made with very heavy shallow transverse floor-beams about 5 ft. apart which support longitudinal steel troughs carrying wooden sleepers under each rail. The floorbeams were made of a pair of 10-in., 25-lb. channels back to back with an 8x¾-in. top cover plate and a 9¾x½-in. bottom cover plate. The ends of the floorbeams were riveted to gusset plates, which help make the connection to vertical web stiffeners in the main girders. The rail troughs were made with two 3½x6x3½ Z-bars, one 15½x5/16-in. bottom plate, two 3½x3½-in. wide angles and two 5x3½x½-in. guard angles. The total weight of the floor was 696 lb. per linear foot of single track.

The structures for the 40th St. track elevation of the Chicago Junction Ry. were designed by Mr. W. M. Hughes, consulting engineer, and were built and erected by the American Bridge Co. In selecting the types of shallow floor, very careful consideration was paid not only to the different constructions already described here, but to several other types which have been previously used by other engineers. Among the more important of these was a system of transverse troughs made with special U-shaped plates rolled by the Pennsylvania Steel Co., which are arranged as shown in the accompanying diagram, with their flanges turned alternately up and down and overlapping so as to be riveted together with single lines of rivets at a considerable height above the bottom of the trough. This feature makes the trough watertight, and its strength in flexure can be easily varied by rolling the trough top or bottom to any required thickness. The ends of the trough rest directly on the lower flange angles of the main girders and the inverted sections are secured to the girder webs with bracket angles. For a trough 10 in. deep over all, the weight of the floor with ballast is 580 lb. per linear foot of single track above clearance line.



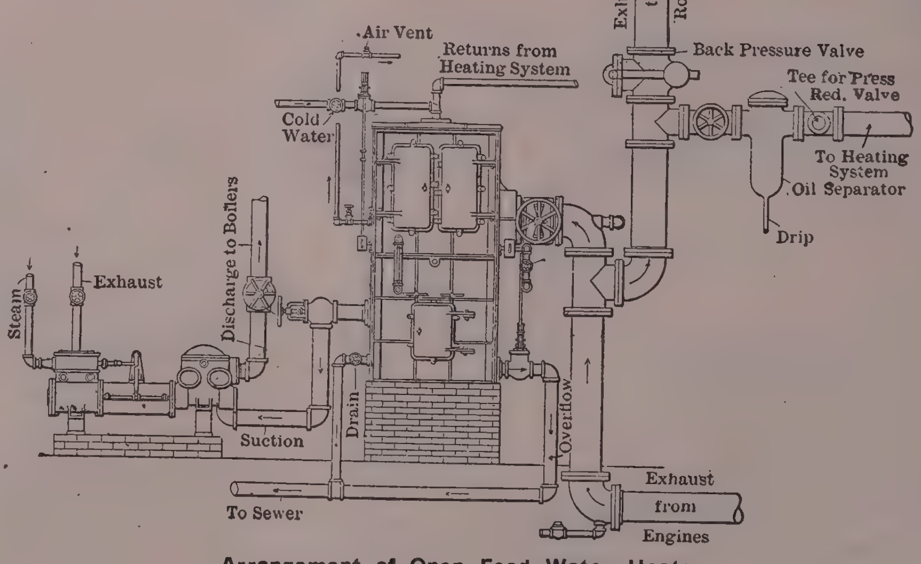
Arrangement of Pump, Receiver and Closed Feed Water Heater.

A combination of these floor troughs with a beam and stringer floor is made by using 18-in., 55-lb. transverse I-beams 6 ft. 8 in. apart, which are web-connected and knee-braced to the main girders, but are clear of their lower flanges. Longitudinal 12-in., 40-lb. I-beams are web-connected to them 5 ft. each side of the center, and support on their webs and lower flanges transverse trough sections which receive the ballast and reduce the width of the latter 3 ft. below what would be required if the troughs were connected directly to the main girders. This floor and ballast weigh 650 lb. per linear foot of single track and is 28½ in. deep. Another variation is made by the use of shallow plate-girder floorbeams 8 ft. 4 in. apart, which support on their lower flanges longitudinal troughs 6 in. high made with the Pennsylvania Steel Co.'s shapes. This floor has an extreme depth of 28⅜ in. and with ballast weighs 700 lb. per linear foot of single track.

Notes on the Use of Feed-Water Heaters in Connection with Heating Systems.

A paper read before the American Society of Heating and Ventilating Engineers by Wm. G. Snow.

While it is a fact, with which heating engineers are familiar, that every 10 deg. rise in the feed-water temperature corresponds to about 1 per cent. saving in fuel, this gain in economy is apparently frequently overlooked by manufacturers and owners. Feed-water heaters faulty in design or of insufficient capacity are installed; live steam is used where exhaust would do as well; condensation is allowed to go to waste which could easily be utilized; and heat units which should be saved are lost in other ways.



Arrangement of Open Feed Water Heater.

It is the purpose of this paper to point out certain features in the application of feed-water heaters in connection with heating systems. In certain kinds of manufacturing plants having many hot, greasy drips from machines, this water is made to flow through the pipes of a horizontal heater, as shown in the accompanying illustration of the arrangement of closed feed-water heaters in a heating system, the boiler feed water filling the space between the tubes and the shell. Exhaust from pumps and other apparatus may be discharged through the same heater if desired. The coldest feed water surrounds the lower pipes containing the least hot drips, so that they pass from the heater to the sewer at relatively low temperatures, having transferred most of their heat to the feed water.

The flow of hot condensation through such heaters is apt to be irregular, and in most cases would be hardly sufficient to bring the feed water to the desired temperature, therefore it is customary to use a regular closed heater as a reheater supplied with exhaust steam from the main engine. Valved by-passes are provided as indicated for use in case of repairs or cleaning.

In some buildings, cold water en route to the feed-water heaters is forced through coils placed in drip tanks and blow-off tanks for the purpose of utilizing some of the heat that would otherwise be wasted, and to provide for cooling the water that would cause injury to sewer connections if discharged at too high a temperature.

Until recent years the method most commonly adopted in large city buildings is shown in the accompanying illustration of the arrangement of an open feed-water heater in a heating system. The receiver should be placed well above the suction valves of the pump to provide sufficient head to cause the water to properly follow the piston and prevent the racing of the pump.

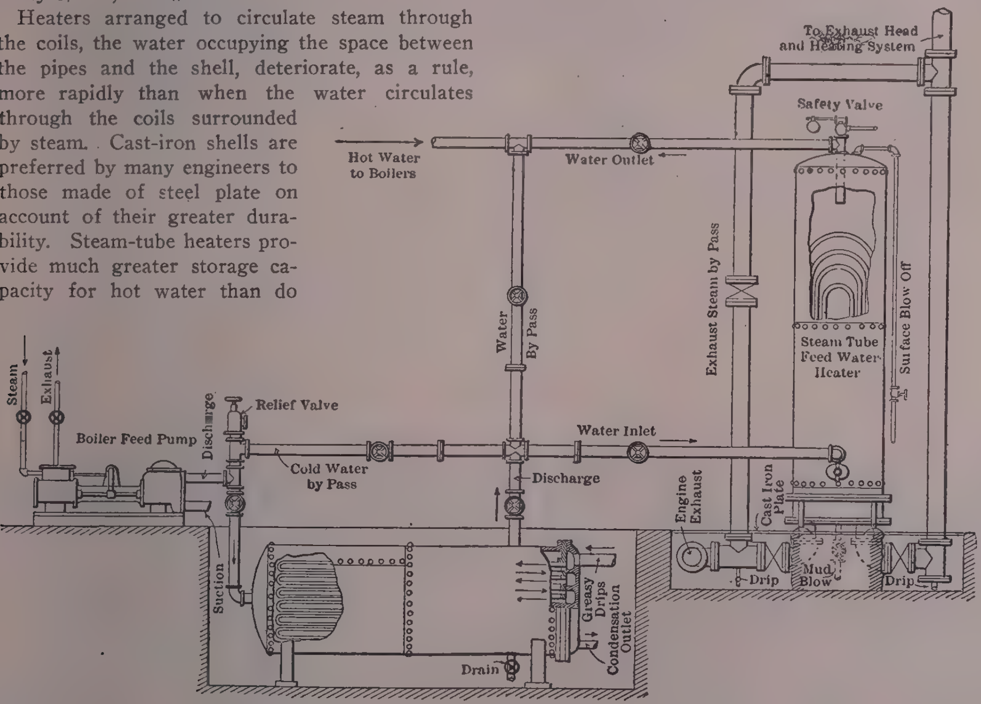
Closed heaters are of the steam-tube or water-tube type, the expansion of the tubes being provided for, as a rule, (1) by the use of U-shaped tubes; (2) by tubes fixed at both ends, the drum at one end being fitted with an outlet pipe working through a stuffing box; (3) by means of corrugated tubes fixed at both ends; (4) by the use of coils of brass or copper pipes.

Tests on water-tube feed-water heaters are stated to have shown that when the water was pumped through the heater at such a rate that the final temperature was within 15 deg. of the temperature of the steam, the transmission per square foot of tube surface was about twice as great as when the water was pumped through so slowly that its final temperature was within 5 deg. of the temperature of the steam. This shows that when a closed heater of this type is forced the efficiency of the heating surface is greatly increased, due to the more rapid rate at which the water is forced through the pipes, and to the greater difference between the temperature of the steam and the average temperature of the water. Steam-tube heaters have a relatively small over-load capacity on account of the sluggish circulation of water between the pipes and the shell.

Closed heaters generally contain from one-third to one-half square foot of heating surface per horse-power, which, on the basis of raising 30 lb. of water per hour from, say, 50 to 200 deg., is equal to a heat transmission of from 30 x (200 — 50) = 4,500 heat units to one-third or one-half square foot, or 13,500 or 9,000 heat units per square foot respectively. As such surface becomes fouled by the accumulation of scale or sediment on one side and cylinder oil on the other, the efficiency of the heater rapidly decreases.

It is probably safe to say that closed feed-water heaters bought in competition are seldom provided with sufficient surface to raise the temperature of the boiler feed water to more than 200 deg. Closed heaters of the steam-tube type must have shells strong enough to withstand a pressure in excess of that in the boiler. A relief valve should be placed in the pump discharge line, otherwise excessive pressure will be produced in the heater when the boiler-feed valves are suddenly closed, and will cause undue wear and tear.

Heaters arranged to circulate steam through the coils, the water occupying the space between the pipes and the shell, deteriorate, as a rule, more rapidly than when the water circulates through the coils surrounded by steam. Cast-iron shells are preferred by many engineers to those made of steel plate on account of their greater durability. Steam-tube heaters provide much greater storage capacity for hot water than do those of the water-tube type, as might be expected.



Closed Feed Water Heater in Heating System.

Storage capacity means that more time is afforded for the settlement of impurities, any heavy sediment being removed through the mud-blow, lighter impurities being discharged through the surface blow-off.

The piping in the illustrations referred to show full-sized by-passes, which are commonly employed to give the most efficient circulation of steam through the heater. The condensation from this steam is wasted to the sewer.

Since only a portion of the exhaust steam is condensed, branch pipes to and from the heater considerably smaller than the main exhaust pipe are sometimes used. When this is done care must be taken to properly vent the heater to prevent air binding. When water-tube coil heaters are used, one or more coils are sometimes connected with the hot-water tank or generator that supplies hot water to the building on the same principle as a water back in a range, the water being reheated by live steam coils in the tank.

A third illustration shows a modern method of handling the condensation from a heating system, at the same time providing for the heating of an additional water supply required by the boilers, the feed-water heater combining also the function of a receiver for returns from the heating system.

It is unnecessary to force all the exhaust steam through a feed-water heater of the direct contact or open type, since the condensation of about one-sixth of the engine exhaust is sufficient to heat the water necessary to take its place in the boiler.

Assume, for example, that the engine is exhausting to the atmosphere with practically no back pressure. The latent heat of steam at atmospheric pressure is 966 heat units. To heat 1 lb. of water from, say, 50 to 210 deg., requires 160 heat units, equivalent to the amount contained in about one-sixth pound of exhaust steam. If all the exhaust steam is passed through the heater about five-sixths of it passes up the exhaust pipe uncondensed, and the passing of this oil-laden steam through the separator and the heater imposes an unnecessary burden on them, besides adding to the cost of the piping due to the by-pass required.

A valved by-pass aside from the cost introduces an element of danger, since in case of faulty operation of the valves, the heater would be subjected to an excessive pressure which would be likely to cause its disruption.

With open heaters practically no resistance is offered to the ingress of exhaust steam, hence no appreciable increase in back pressure on the engine is necessary to keep these heaters properly supplied with steam.

Direct-contact or open heaters, in which the steam and water come into direct contact, always retain their maximum original efficiency in the transference of the heat in the steam to the water. No fouling of surfaces affects their efficiency. The main criticism raised against them by some engineers is the dangers from oil getting into the boilers.

Of course the character of the water has much to do with the selection of a heater, the open heater being very commonly used in sections where bad water is encountered. This type of heater affords ample space for the settlement of organic impurities, and the high temperature secured precipitates the carbonates of lime and magnesia, which are deposited in a settling chamber provided for the purpose.

To precipitate the sulphates, temperatures in the vicinity of 300 deg. are required which are far beyond the range of exhaust steam heaters. This paper, however, is not a treatise on chemical heaters, although those of the open type are frequently fitted with tanks and apparatus for introducing chemicals for softening the water, which must be supplied in addition to the returns from the heating system or during the season when heating is not required.

Returning now to the question of eliminating the oil contained in the steam, the greater portion of this is removed by the separator; the coke filter, some 18-in. thick, being depended on to reduce the amount left to a harmless percentage. These heaters may easily be re-coked; in fact, all portions of the interior are accessible through large doors made tight by the use of gaskets. The great and increasing number of such heaters in daily use would appear to the unbiased to be pretty satisfactory proof that the oil question is successfully disposed of.

Some engineers object to the pumping of hot water, which is necessary when using direct-contact or open heaters, they claiming that the hot water causes rapid deterioration of packing and valves. When the heater is set sufficiently high to bring the water level 3 ft. or more above the suction valves of the pump, no trouble should be experienced in pumipng hot water, as there will then be sufficient head to cause the water to follow the piston and prevent racing.

Sometimes when a heater is set low with reference to the pump, the substitution of lighter springs on the suction valves will overcome racing that may have been experienced.

As to the best material to use for valves for hot-water service, many engineers prefer all metal valves instead of hard rubber. Such valves give good service and are considered by many to be worth the additional cost. Somewhat more care must be exercised in selecting piston packing than for cold-water pumps, especially in the case of end or center-packed plunger pumps, but this is only a detail, and hundreds of plants have pumps working successfully under the conditions stated.

The great storage capacity for hot water in direct-contact or open heaters is an advantage in meeting any sudden increase in the load on the boilers. The condensation returned from the heating system is from steam that has passed through a separator. After this condensation has passed through the coke filter in the heater, it is in condition to be returned to the boilers. All steam condensed in heating the water in the heater is likewise returned to the boilers, and is no inconsiderable item of economy when water must be bought at city rates, amounting, as it does, to not far from one-seventh of all the water required. There is no denying the fact that a greater amount of attention and more intelligent attention is necessary when the most efficient modern devices are used to save fuel. The extra cost of such additional attendance is, however, a very small item in comparison with the saving that is secured.

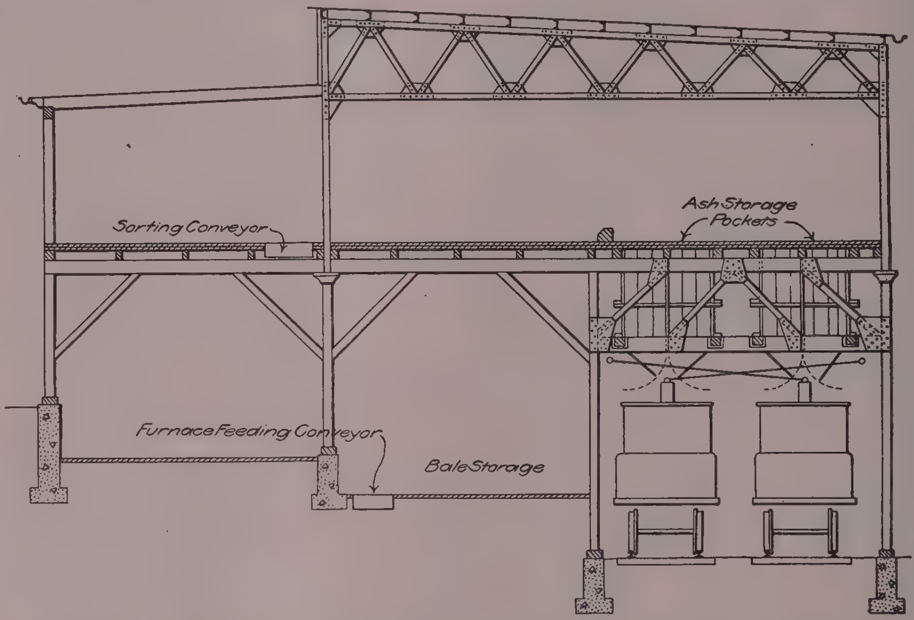
Crude Oil Fuel is being used in the boiler plant of the Eagle Flour Mills at Newton, Mass., at a cost comparing very favorably with that of coal. About 170 bbls. of oil are burned per week at a cost of from 3.99 to 4.69 cents per barrel of flour manufactured. The fuel cost when using coal averaged 4.6 cents per barrel of flour output, not taking account of the labor cost of handling the coal and stoking. The burner used is the Hammel crude oil burner, which uses steam for atomizing the liquid fuel, and no change was made in the furnace except to cover the grates tightly at the rear with bricks and sand, and at the front with half bricks laid loose with 1 in. air spaces; at the front close to the furnace doors an 8x12-in. air opening was left clear on either side. Combustion is absolutely smokeless when the burner is properly regulated.

A Rubbish Incinerator Plant in Brooklyn.

The disposal of refuse in the city of Brooklyn is entrusted to private enterprise, the contract for the removal of ashes and rubbish waste having been awarded some three years ago to the American Railway Traffic Co, a company subsidiary to the Brooklyn Rapid Transit Co., which makes use of the street railway and suburban lines of the latter company to haul the waste material to swamp-land dumps in the outlying districts near the ocean shore. The value of this waste material for filling in and reclaiming bog land rendered it possible to secure extensive districts of salt marsh in southern portions of the city for dumping purposes, and, accordingly, a very extensive and complete equipment was provided for the receiving and transporting the waste material collected by the Street Cleaning Department. The equipment consists of a number of receiving stations distributed throughout the city to which the refuse is hauled by the collection carts of the department, and there sorted, where necessary, and loaded into transporter buckets on motor freight cars for transportation to the dumps. There the buckets are handled from the cars by cranes and distributed by small dump cars upon easily movable tracks of standard gage.

The system of the American Railway Traffic Co., which has been carefully adapted to the street cleaning service requirements, embraces 13 district receiving stations located at points approximately two miles apart throughout the city, to which the receipts of both the ash carts and the paper and rubbish collection carts are delivered by the Street Cleaning Department of the city. These stations all have dumping stands from which the ash carts discharge directly into large transporter buckets, and means are provided in all cases for either loading directly into the buckets while on the motor freight cars, or for hoisting the buckets from loading positions on the cars by cranes after being loaded. The stations have trackage connections to the street railway lines by which the cars are run directly to the dumps. The rubbish collections are arranged to be spread out on the floor of the station to permit of the customary picking and sorting by the rag pickers, after which it is baled for removal. The transporting buckets are large square steel boxes, which have a capacity of 9¼ cu. yd. each, and all are fitted with lifting trunnions, so located as to permit easy dumping, yet cause them to return naturally to an upright position when emptied. The crane equipment consists of Shaw electric traveling cranes at a number of the stations for transferring transporter buckets to the freight cars, and at the dumps for handling from the cars to standard-gauge cars. For the latter purpose, motor-operated derricks are used.

During the early periods of the contract the rubbish waste was hauled to the marsh dumps, together with the ashes, and portions of it were burned intermittently in piles, but owing to weather conditions, the greater part was allowed to remain. It was evident from the outset that the rubbish receipts were not a satisfactory material for filling in the reclaiming of bog land, the waste paper creating a general nuisance by being blown about, and resulting in very unsanitary disposal. It was early in the progress of the work that the suggestion was made to burn the rubbish and reclaim heat from the furnaces. A small Decarie furnace was installed in the station at Third Ave. and 3rd St., in close proximity to the central power plant of the Brooklyn Rapid Transit system. The results obtained from this installation were satisfactory from the beginning, the boiler of the plant proving effective in furnishing sufficient steam for the heating of all the feed water for the boilers of an adjacent 30,000-h.-p. power plant. The success of this installation was influential in determining the design of a large new plant of ample capacity to handle a large proportion of the city's rubbish receipts, which is now complete and in operation.



Cross-Section of the Receiving Station of the Brooklyn Incinerator.

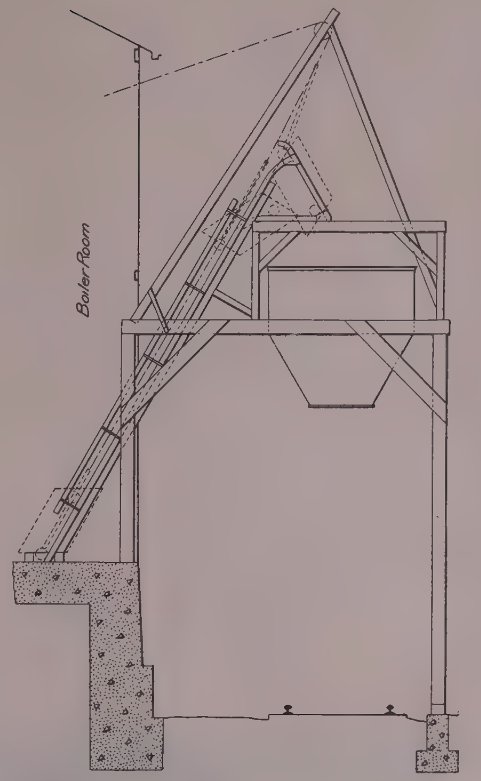
Platform for Receiving Baled Rubbish.

The Local Receiving Station on the Upper Floor.

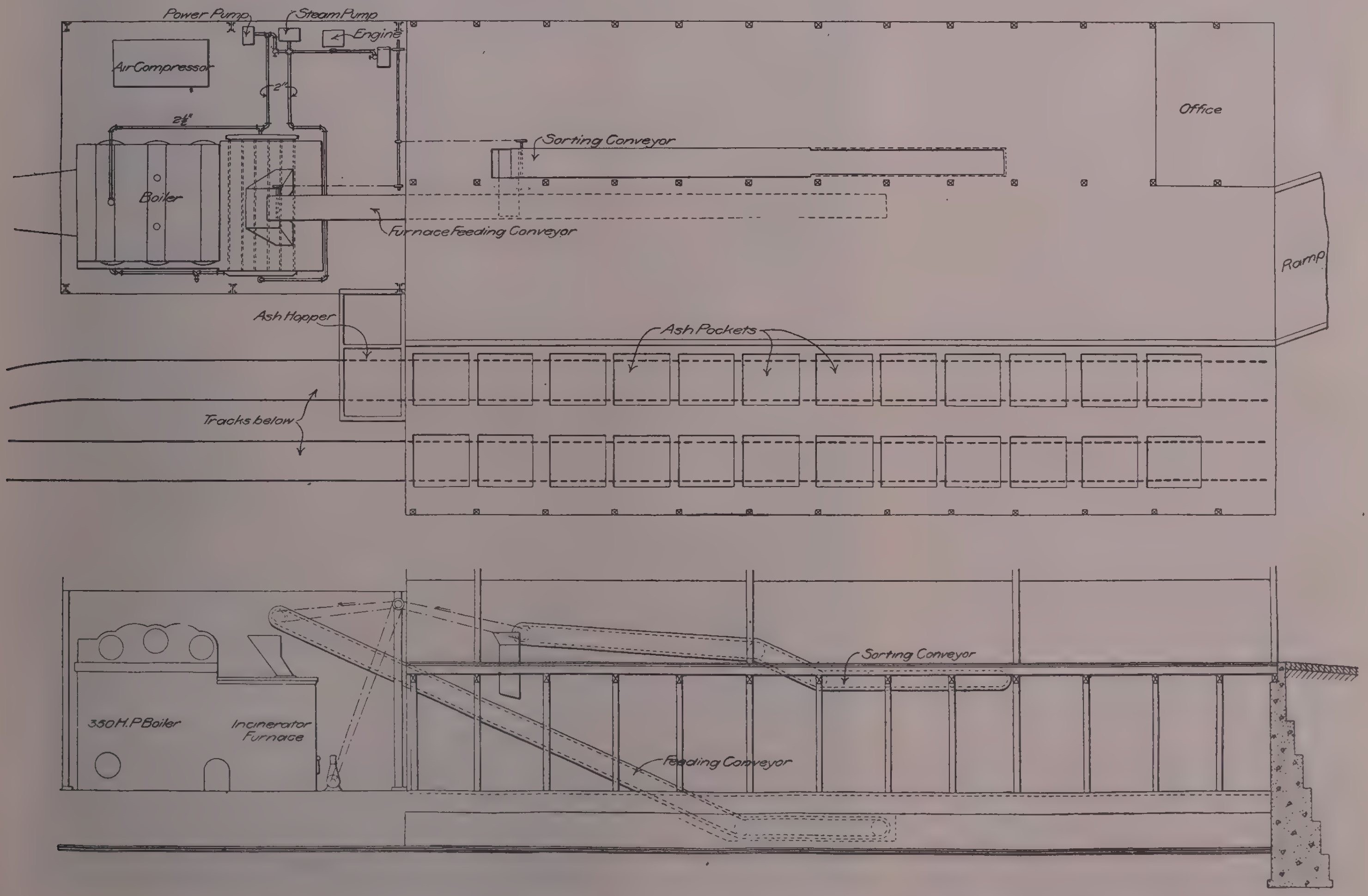
The prime consideration in the design of the new plant was that it should be effective in steam production, and it was accordingly found advisable to locate it so that the steam could be utilized to the best advantage. At the time of its construction, the railway system was bringing to completion a large new repair shop plant in the East New York district of Brooklyn, and the opportunity was thus offered to utilize the incinerator plant for the heating of this shop plant and for power purposes. It was accordingly located on property available across the street from the shop buildings on the corner of Gillen Place and Bushwick Ave., from which steam connections to the shops could be made by piping beneath the street. This location also proved convenient of access for the city collection carts as well as for the track connections for the freight cars for transportation.

The building erected to house the plant is of steel and wooden frame construction with corrugated-iron sheathing, and is in two sections, one, two stories in height for the receiving station, and the other for the furnace and boiler and auxiliary equipment. The former is 40 x 104 ft. in plan, with an 18-ft. lower floor and a minimum clearance under roof beams on the upper floor of 10 ft. The boiler house is a 32 x 40 ft. building, with a clear headroom of 24 ft. for steam piping connections above the boiler, and has its floor level 2 ft. above the middle platform level of the receiving station lower floor. Both the boiler room and the upper story of the receiving station have roofs of galvanized corrugated-iron sheathing, carried on steel roof trusses, which are fitted with monitors for lighting and ventilation. The track entrance to the receiving station for accommodation of the motor freight cars is made through the rear of the lot, passing to the rear of the boiler room to the depressed portion of the receiving station lower floor. This space is 20 ft. in width and contains two tracks, one near the platform for unloading baled rubbish to the feeding conveyor of the incinerator plant, and the other at the rear to accommodate cars with the transporter buckets for loading direct from the ash storage pockets above.

The receiving station at this point, has, in fact, two functions, one the receiving of ashes and rubbish collected in the local district adjoining the station, for the usual sorting and disposal, and also the receiving of rubbish from other stations for incineration, the former work being confined to the upper floor, and the latter to the lower story with platform and tracks. On the upper floor ashes are received at one side, provision being made for receiving directly from the collecting carts by dumping into temporary storage pockets suspended over side tracks beneath. These pockets are built with their tops flush with the upper floor for ease of dumping from the city collection carts, and each has a capacity of 9 cu. yd. corresponding to that of the transporter buckets carried on the freight cars. They are arranged, 24 in number, 12 over each of the tracks below so that when the motor freight cars are run in below, their transporter buckets are properly spaced for dumping the storage pockets directly into them without shifting the cars; the pockets have double-hinged bottoms for ease of dumping and ratchet winding gear for closing the bottom doors.



Ash-Handling System for the Incinerator.

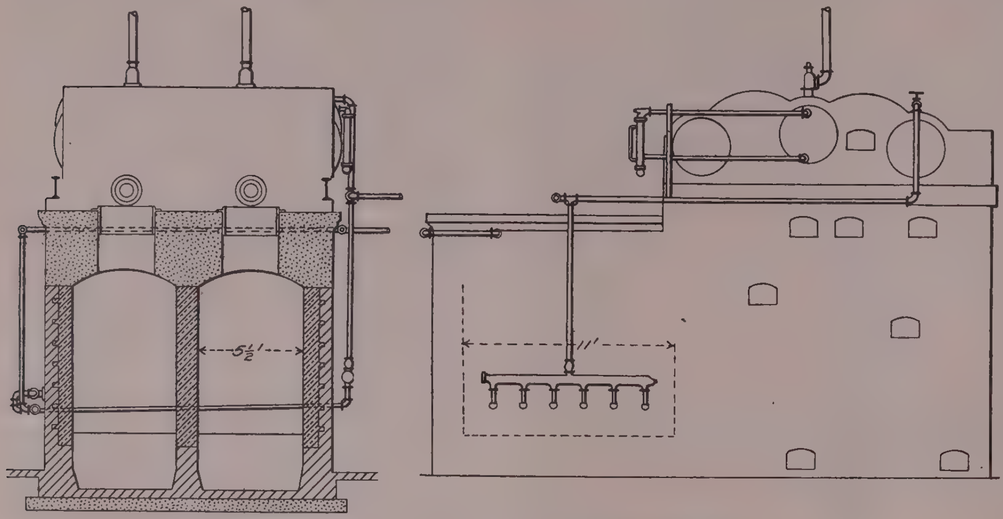


Details of Receiving Station, Conveyor Arrangement and Furnace of the Incinerator Plant.

The rubbish is received on the opposite side of the upper floor where provision is made for the rag pickers to sort out any material or junk of value before delivery to the incinerator. A slow-moving apron conveyor with 4-in. continuous vertical sides serves the picking table and carries the material on from the picking stand to the incinerator furnace. This conveyor, the arrangement of which is shown in a longitudinal elevation of the building, is placed horizontally and is depressed slightly below the floor toward the front of the building to permit the rubbish carts to dump directly on it. After a horizontal run of 22 ft., it pitches upward at an angle of nearly 30 deg., and at a point 7½ ft. further to the rear, begins a nearly horizontal run, 28 ft. long, pitching slightly upward toward the rear, which serves as the picking table for the rag pickers. The elevation of the conveyor above the floor at the picking table has been made convenient for the pickers, varying from 30 in. at the front and to 4½ ft. at the rear, where it is discharged to the incinerator feeding conveyor. This conveyor is driven normally at a surface speed of 35 ft. per minute, but the speed can easily be varied from the driving engine to accommodate the pickers or requirements of the furnace.

The central platform of the lower floor on which the baled rubbish is received from other stations is 4 ft. above level of rail of the adjoining track to facilitate handling from the freight cars. The bales, which vary in weight from 350 to 500 lb., are transferred to the platform by a chain hoist on a trolley runway over the platform, with which the bales are also piled out of the way as they come at night in excess of requirements. These bales are opened as needed and the material thrown on the furnace feeder conveyor, a second apron conveyor similar to the picker conveyor, which extends from the platform up to the furnace feeding hopper, a vertical rise of 21 ft. This conveyor, which is operated normally at a surface speed of 50 ft. per minute, has a horizontal run 16½ ft. in length, depressed slightly below the platform level, from which it is carried upward at an angle of nearly 30 deg.

to the furnace-feeding hopper, a distance of about 60 ft. This conveyor is also of the overlapping type, with 4 in. vertical sides to retain the material carried. Both conveyors were built by the Weller Mfg. Co.



Details of the Boiler and Furnace Settings.

The incinerator furnace is of a special design prepared by Capt. A. R. Piper and Mr. John Walker, of the American Railway Traffic Co., with large combustion chambers and other special features to particularly adapt it to steam-producing service. The furnace is a large brick structure independent of the boiler setting, with a feeding hopper at the top and stoking and ash doors at the lower front, in which the rubbish is consumed. The products of combustion pass to the stack through the boiler, thus reclaiming a large proportion of the heat combustion. The boiler furnace is double, each half having a grate area of 60½ sq. ft., and contains two sets of grates, one an upper basket grate of water tubes into which the rubbish is delivered first for initial combustion, and the lower, a set of plain cast-iron grates with 1-in. air spaces, on which combustion is completed. The water-tube grates are of extra-heavy 1½-in. wrought-iron pipe through which feed water for the boiler is passed for preheating, while the lower grates in 5½-ft. lengths, are distributed longitudinally in the setting. The furnace is fed through two 24 x 30-in. feed openings in the top toward the front on either side, to which the rubbish is delivered from the conveyor by a two-legged hopper 4 ft. square at the top. The furnace, in fact, has four feed holes, two of which are at the rear, but those have been closed as it was found that by feeding at the front side only the slag from molten glass and other refuse could be more easily removed from the front side than when distributed all over the grate area.

Each half of the furnace has a combustion chamber 8½ ft. in height above the lower grates to permit complete consumption of the rubbish which enters at the front side of the furnace and is gradually worked toward the rear as it burns, with the aid of stoking. There are four balanced stoking doors at the front, giving access to the entire width of the grate. The ash pit beneath the grates is 30 in. in depth. The furnace is lined with fire-brick blocks at the sides and plain fire-brick at the top, the latter being anchored to the concrete arches above. At the rear of either half is an opening 5 ft. square for delivery of the products of combustion to the boiler setting, where it is caused by baffle walls to make three passes through the tubes of the boiler. A 100-ft. radial brick stack with a 5½-ft. opening and built by the Alphons Castodis Chimney Construction Co., serves the furnaces.

View of the Incinerator Furnace, Ash Skip and Conveyor.

Owing to the large amount of ashes resulting from the mixed character of the material burned, special provisions have been made for their removal from the boiler room. A large steel plate hopper was installed outside of the boiler house to the rear and over the inside track, into which the ashes from the furnace are hoisted, and thence dumped to transporter buckets on the motor freight cars. The hopper has a capacity of about 10 cu. yd., so that when full a transporter bucket may be run underneath and loaded from it. The ash hoist consists of a steel skip holding about ½ cu. yd., which travels up an inclined runway with provisions for automatic dumping at the top, as indicated in an accompanying sketch. The skip is filled by shoveling when at floor level and is hoisted by a simple capstan winding gear near the furnace front.

A 350-h.-p. Stirling water-tube boiler, arranged for continuous operation, with three steam drums and three sets of tubes through each of which the gases of combustion make a separate longitudinal pass on the way to the stack, is installed for steam production. The tube surface consists of two hundred and sixty-four 4-in. tubes presenting a total heating surface of 3,500 sq. ft. The steam drums are 36 in. in diameter by 14 ft. long, while the mud drum is 42 in. in diameter by 12 ft. in length. Two 4-in. safety valves and a 2½-in. blow-off connection from the mud drum through a special blow-off valve are provided.

The basket grate of the furnace consists of six 1½-in. wrought-iron pipes which are passed horizontally, at distances 19 in. apart, through the two cells of the furnace, and connect to heavy cast-iron headers at either side of the setting. The header at one side is connected by a 2½-in. line to the mud drum of the boiler and that on the other side to the feed pocket of the rear steam drum, and as the grate tubes are pitched upward slightly toward that side, a natural circulation is induced in that direction to keep the tubes from burning. The feed connections, which are in duplicate of 2-in. pipe, are made into this system, one connecting to the upper line leading to the steam drum and the other to the lower header on the rear side. The boiler feeding pumps are in duplicate, one a power pump and the other a Worthington duplex boiler feed pump.

In the design of this plant, one requirement was that it should be arranged for continuous operation, as steam is required continuously throughout winter weather for the heating service at the shops and other buildings of the company. It is therefore arranged to handle the rubbish at as nearly a continuous rate as possible, the local receipts of rubbish being sorted and burned as fast as received during the day, while that received in bales from other stations is used to supplement the local supply in day and is depended upon entirely at night. About 300 bales are received every night from the other stations. These bales are stored on the receiving platform next to the inner track and are broken open during the night and following day as required by the furnace. This furnace cannot handle the rubbish receipts from all the stations, but more than one-half of the city's rubbish is now consumed by it. An unfortunate feature is that the material connot be held in storage for any length of time in baled form, as it contains sufficient organic matter to cause heating to occur within less than 48 hours. Care is taken therefore to burn the rubbish about as fast as received, although wooden boxes and bulk wood are often held for short periods to provide for times of extra duty, or for firing by hand to permit shutting down the conveyors.

The amount of heat available from the rubbish incinerator is considerably more than was anticipated, the supply of steam having from the first been far in excess of requirements. Early in the operation of the plant is was found that the rated capacity of the boiler could be developed continuously with no difficulty whatever, the furnace consuming the material very effectively, whether wet or dry, and in all conditions of weather. In a test that was recently made of the entire plant, when operated to full capacity, the boiler developed 470 h.-p. continuously for a number of hours, although a number of the conditions were unfavorable, indicating that the equipment is capable and efficient as a power producing auxiliary. It has furthermore not proven a nuisance to the surrounding nighborhood, the slight smoke being carried well above the buildings in the vicinity by the 100-ft. stack. The smoke produced, in fact, amounts to merely a light vapor, except when the furnaces are being stoked; then only a decided volume of smoke issues from the stack.

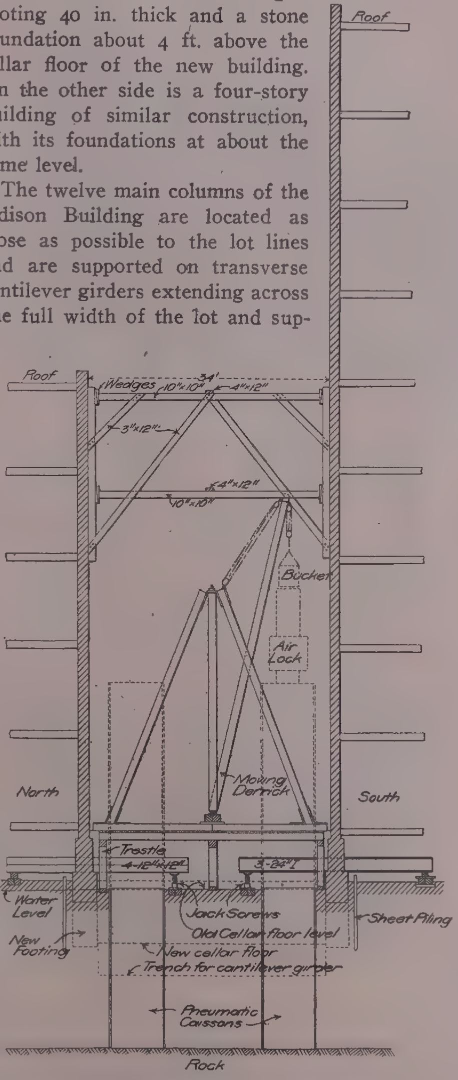
Owing to the excess of steam produced by the plant, a contract was recently made by the company with a neighboring brewing company to supply the steam plant of its brewery with power, it being intended to take care of approximately 200 h.-p. in steam continuously at 110-lb. pressure. For this purpose a 5-in. steam line, 1,400 ft. in length, has been extended through the shop buildings and grounds beyond, to connect with the steam system of the brewery plant. This line is carried out of doors the greater part of its length and will be covered with 1¼-in. mica pipe covering—a special form of insulating covering supplied by the Mica Boiler Covering Co., Montreal, Can. It is impervious to the weather and thus particularly adaptable to outside conditions. The pipe line has screwed joints except at every third joint, which is a flanged connection to permit disconnections to be made without disturbance to the remainder of the line. It has 13 right angle turns with swiveling joints to provide for expansion and is trapped for drainage of condensation at both ends and toward the middle.

The officers of the American Railway Traffic Co. are Mr. E. W. Winter, president, and Mr. J. F. Calderwood, general manager, also of the Brooklyn Rapid Transit System. Captain A. R. Piper, who has had extensive experience in a former connection with the New York Street Cleaning Department, is superintendent, and has been responsible for many of the innovations introduced in the design of the plant.

The Substructure of the Edison Building.

The 34 x 108-ft. Edison Building at 100 Water St., New York City, will be a steel-cage structure, having a height of six stories above the ground, with provision for the future addition of six stories more. It runs through the full width of the block and has a front at 134 Pearl St., where the elevation of the curb is 8 ft. higher than that of Water St. and affords room for a basement and cellar, the later having its floor about 15 ft. below the Water St. curb and 7 ft. below the ground-water level. The soil here is of the ordinary sandy character usually found in this part of the city, containing some clay and boulders, and has a depth of about 30 ft. from the Water St. curb to the surface of the rock. On one side of the building there is an old eight-story building with the ends of the floorbeams carried by a brick wall having a footing 40 in. thick and a stone foundation about 4 ft. above the cellar floor of the new building. On the other side is a four-story building of similar construction, with its foundations at about the same level.

The twelve main columns of the Edison Building are located as close as possible to the lot lines and are supported on transverse cantilever girders extending across the full width of the lot and supported by ten 7x7-ft. piers and two 7x14-ft. piers. All of the piers are of concrete carried by the pneumatic caisson process to solid rock.



Needlebeams and Bracing.

Below the water line the soil has many of the characteristics of quicksand and it was evident that the open excavation and the sinking of the caissons so far below the old foundations would tend to undermine them, so it was deemed necessary to provide against their settlement before construction operations were commenced. The dimensions of the long and narrow lot were unusually favorable for bracing the old buildings together in order that their reactions should be balanced. This was accomplished as shown in the cross-section, by building trussed transverse wooden struts between them at the fourth and fifth-story levels in vertical planes about 15 ft. apart. Vertical bearing timbers about 25 ft. long were set against the brick work and the cross timbers were cut to clear their faces by about 6 in. and were brought to solid bearing by pairs of folding oak wedges tightly driven at both ends. The diagonal pieces were securely spiked across the verticals and horizontal and center lines of longitudinal struts were bolted to them making a simple and efficient system of overhead bracing abundantly strong to prevent any initial movement of the buildings toward each other.

The positions of the twelve caissons were accurately located adjacent to the side walls and in each of the spaces, with about 10 ft. clear between them, two openings were made through the old brick walls just above the basement floor and as far apart as possible. In each of these openings a compound needle-beam, about 24 ft. long, was placed with its center approximately in the plane of the wall, thus securing alternate spaces of 7 ft. and 10 ft. between the needle-beams which occupied the spaces between the pairs of caissons and were supported at their outer ends by pairs of jack screws resting on longitudinal timbers in the bottom of the excavation. The opposite ends of the needle-beams were supported without jack screws on longitudinal sills laid on the cellar floor. The caissons were thus enclosed in rectangular spaces bounded by the old walls, the needle-beams and the longitudinal sills, but were clear of all of them so that they could be sunk without obstruction. The condition of the wall was good enough so that it was deemed prudent to trust the brick-work to arch across the 10-ft. spaces opposite the caissons and carry the load, which was estimated at 15 tons per lineal feet for the eight-story building, safely from needle-beam to needle-beam, a confidence which was justified by the result of subsequent operations. The longitudinal sills under the outer ends of the needle-beams were made with double lines of long 12 x 12-in. timbers carefully leveled and reaching continuously from end to end of the lot. They were made to break joints and were spliced, when necessary, by upper timbers so as to distribute the load from the needle-beams over a large area of the surface and to enable sections of the sills to be conveniently removed.

Under the four-story building the needles consisted of two tiers, each made with two 12 x 12-in. timbers, four in all, except at the corners, where six timbers were used. For the much heavier loads of the eight-story building, three 24-in. 80-lb. I-beams were used for each needle-beam, except at the corners, where four I-beams were used. The needle-beams were set with the outer ends a few inches lower than the ends in the adjacent buildings and were screwed up until they supported the full weight of the walls. When the excavation and caisson work was commenced for the new building watch was kept on the needle-beams day and night and the jacks under them were frequently screwed up to compensate for the gradual settlement that took place. In this way the needle-beams were eventually screwed up several inches and the walls were successfully maintained in their original positions. Three lines of 12 x 12-in. longitudinal timbers were carried across the full length of the lot, one in the center and one close to each side and were supported on short vertical posts and sills to form a trestle on which there was seated a stiff-leg derrick with a 44-ft. boom of 10-tons capacity. The derrick was slid on the beams from one end of the lot to the other and handled the caissons, air shafts, locks, muck, concrete and other materials, as the caissons were built successively from the Water St. to the Pearl St. front.

All of the caissons were of simple construction, made with 3-in. plank bolted to 4 x 10-in.

horizontal inside frames from 4 to 6 ft. apart. The lower ends of the vertical wall planks were sharpened to form a cutting edge, which on account of the comparatively short distance sunk was not reinforced with steel plates or angles as is customary. The caissons and cofferdams above them were made continuous and integral and were built of single-length planks of a maximum length of 29 ft. The largest caisson weighed 9 tons and like the rest was finished at the contractors' yards and delivered, complete, to the building on trucks.

The caissons were sunk with a maximum pressure of about 15 lb. above the normal at a rate of about 12 ft. per day, four men working in each of the 7 x 7-ft. caissons. Owing to the comparatively narrow width of the caissons and their height, it required considerable skill to maintain their verticality during sinking; this was successfully accomplished, however, by loading and excavating without the use of any outside frames or shores. The cutting edge was sunk to hardpan and usually stopped at about that level. This stratum, although considered inadequate for the footings of the piers, was sufficiently hard to allow the excavation to be made 6 to 8 ft. through it to the rock, without the necessity of retaining the sides.

Sheet piles were driven close to the outer walls in the adjacent buildings and the excavation for the new cellar was continued up to them, removing the old footings and replacing them by concrete walls carried down 12 in. below the cellar floor in the new building. These walls were built in long, continuous sections, the weight of the structure above being transmitted to them in the usual manner through wedging stones and steel wedges. The cellar floor is water-proofed in the usual way with tar and felt flashed up over the faces of the side walls to above the water level.

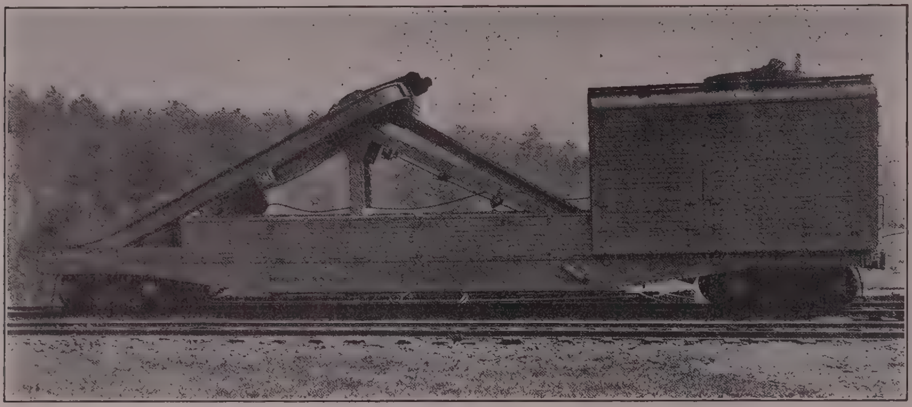
On account of the limited room, two Ingersoll-Sergeant air compressors were placed at right-angles to each other in the Water St. sidewalk vault and were operated by two Westinghouse electric motors belted to them. This arrangement avoided the use of steam on the work and saved considerable obstruction and trouble by the elimination of boilers, coal storage, water supply, etc. A Lidgerwood hoisting engine, which operated the derrick and the booms for draining the pits, was driven by compressed air.

The Bryson-Gamble Co. are the contractors for the substructure, including the shoring of the adjacent buildings.

The Airship for the Wellman North Pole expedition is the largest yet built, having a length of balloon of 164 ft. when expanded and diameter of 52½ ft. Its lifting power is between 15,500 and 16,000 lb., while the load carried, including the crew, apparatus and supplies, will be about 9,400 lb.

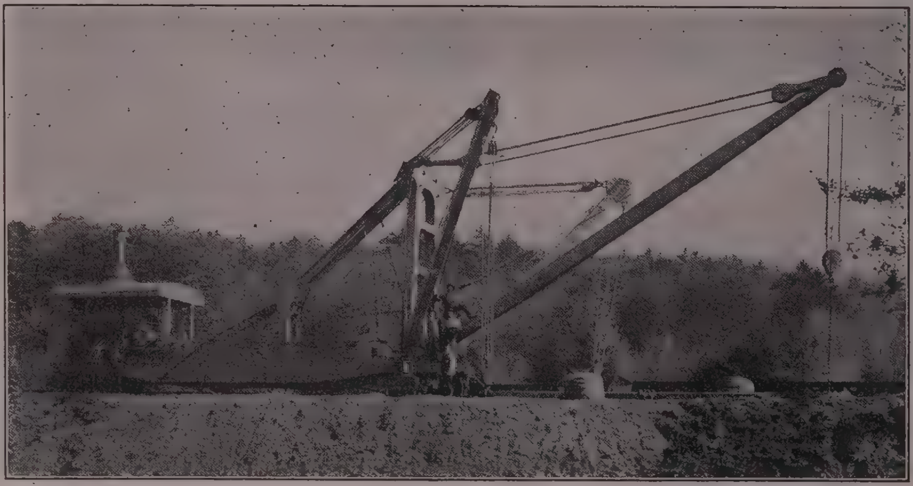
Derrick Cars Used in the Reconstruction of the Poughkeepsie Bridge.

A very important factor in the successful replacement of the girder spans of the approach viaducts of the Poughkeepsie Bridge, described in this journal last week, was the use of the special steel derrick cars mentioned in the preceding article. Their value was so great that without them, or their equivalent, it was not believed practicable to execute the work without adopting some totally different plan, such as the erection of very high and expensive falsework which would have involved a great increase in the cost and in the duration of the work. Up to the time that this work was done, no derrick cars were on the market suited for the purpose and the cars used here were special ones which had never been previously in service.



Derrick Car Ready for Transit.

Each car is 50 ft. long, 14 ft. high and about 9½ ft. wide over all when arranged for transit. It weighs complete with tackle and equipment about 150,000 lb., and is provided with a 50-ft. heavy main boom of 25 tons capacity, and two auxiliary side booms 40 ft. long, of 15 tons capacity.



Derrick Car Ready for Service.

The main boom is made in sections with bolted splices so that the length can be easily and quickly varied in accordance with requirements of different classes of work. By removing one section from the normal length there is provided a 30-ft. boom with a capacity of 50 tons, and by adding one section, a 70-ft., 10-ton boom is secured. These boom capacities correspond to the regular working base of the car; if the latter is increased, as it may be, still heavier loads may be handled without exceeding the capacity of the boom.

There is no mast, but the booms are operated from a transverse A-frame 22 ft. high, which is braced with diagonal struts to the rear of the car. The A-frame and struts are pivoted so as to fold back on themselves and reduce within standards the clearance necessary for the car. The auxiliaries are easily detachable and the main boom is made to slide longitudinally backwards on the car floor and thus reduce all projections within the clearance allowed for regular car sizes. All the apparatus necessary for the operation of the derrick car, its rigging, and all tools required for the erection gang are carried in special lockers on the car. The engine is enclosed in a cab arranged to be partially or wholly open when operating the derricks and securely closed to protect the engine during transportation. The main boom is provided with steam swinging gear and the car is of standard gauge and is fitted with an independent engine capable of propelling the car with the boom fully loaded at a maximum speed of 5 miles an hour, thus making it independent of the locomotive and train service.

The derrick car was especially designed to meet the requirements of general bridge erection, and especially to handle heavy plate-girder spans besides being available for general service as a locomotive or wrecking crane and for use in pile driving, falsework building and general railroad and contractor's purposes. The principal requirements governing the design were to economically handle heavier loads at longer radii than could be done with existing cars; to provide convenient and efficient side anchorage for handling heavy eccentric loads; to provide mechanism for self-propulsion with maximum loads suspended from the main boom; to provide large storage capacity for tools and equipment, to secure the most convenient arrangement for rapid operation; to conform with train clearances and finally to involve the least possible interruption of the service of the derrick in making ready before and after shipment.

The steelwork body is carried on rigid diamond arch bearing trucks equipped with Westinghouse air brakes and friction-draft gear, Janney-Duhoup three stem freight couplers and with hand brakes. The steel-frame cab is made with folding and removable sides and ends so arranged that when open, the upper parts form awnings and the lower parts form cantilever side platforms providing ample working space around the engine. In the cab is a 50-h.-p. Rawson & Morrison double-drum, four-spool hoisting engine and boiler. On each side of the car is a longitudinal bunker about 3½ ft. wide and 4½ ft. deep which is divided into three 5-ft. compartments with hinged and locked tops and outer sides. The deck of the car forward of the bunkers is covered with a ¼-in. protecting steel plate, thus making a convenient working platform.

Two of the rear bunkers are occupied by a rectangular steel water tank, and in another is located a 35-h.-p. Rawson & Morrison engine which drives a sprocket gear engaging the forward axle and providing the locomotive power for the car. This engine, as well as the hoisting engine is of special shape, designed to fit the space available in the car. The remaining bunkers are used for storage of tools, tackles, etc. Provision is also made for installing in some of the tool boxes, an air compressor and receiver for operating pneumatic tools if required. Coal storage is provided in the cab.

The main boom has a closed rectangular cross section made with two vertical flange plates and two built channels with their webs horizontal. It is fitted at the point with inside sheaves for the hoist lines, thus increasing the maximum lift. The topping lines are rove through a block attached by long links to the axle of the sheaves and to a gudgeon at the top of the A-frame. The foot of the boom has a horizontal pin engaging a forged steel block connected to the car frame by a vertical pin and thus providing a universal motion.

The main boom has a maximum swing of 144 deg. When the A-frame is guyed, each auxiliary boom has a total swing of 95 deg., and when it is neither guyed nor anchored it has a swing of 185 deg. The A-frame is built of steel plates and channels, making a very rigid construction. It is connected to the sides of the car by horizontal transverse pivots and is maintained in vertical position by a jointed inclined strut, pivoted at the top of the mast and at the top of a short intermediate vertical post.

In order to collapse the derrick for shipment, the boom is lowered to a horizontal position with the point resting on any fixed support. The pivot is disconnected from its foot and the car is moved forward, causing the boom to enter the chamber between the longitudinal rows of lockers where it travels easily on permanent rollers attached to the boom. The latter thus occupies the full length of the car floor and is safely packed for transportation.

To collapse the A-frame the lower pivots in the upper parts of the inclined struts are removed and the upper part of the strut moves backwards and downwards to the foot of the lower struts carrying the mast with it in a backward revolution to the position shown in the collapsed view. The feet of the upper struts have rollers engaging the insides of the lower strut so that the latter serves as a guide and track for it. These rollers are commanded by a line passing over the top of the short vertical post and back to the hoisting engine so that it can be slacked off and permit the A-frame to collapse. To re-erect the A-frame this line is wound up and reverses the process, revolving the frame back to a vertical.

This operation can be performed in a few minutes and the car, closed for transportation, can be opened and all attachments made and ready for operation within ten minutes after steam is provided in the boiler.

The auxiliary booms are of wood and are attached to the car frame with connections similar to that of the main boom. Their topping lifts are secured to the A-frame by detachable lugs pin-connected to the latter, so that the booms and their tackles can be very quickly connected or disconnected from the car. The lugs are also provided with connections for inclined braces secured at their lower ends by horizontal struts engaging the sides of the car and thus affording a very wide base for eccentric loads. Provisions are made for securing the top of the frame by guys instead of braces. Anchors are also provided to clamp the car to the rails. The main falls and the top falls are each rove with nine parts of crucible cast-steel rope ¾ and ⅞ in. in diameter, respectively. The car is equipped with a 10-ton counterweight to balance eccentric loads and with steel wedges to relieve the springs in the trucks when the car is in service.

These two cars successfully handled 85-ft. girders weighing 36 tons, unloading them from the track alongside, swinging them to position in the structure and moving them back and forth transversely and vertically as required with great ease and rapidity. Each car is operated by three men besides those needed for special lines, and it uses about one ton of coal and 600 gal. of water daily when in full service. The car was designed by Mr. S. P. Mitchell.

The New Scranton Tunnel of the Lackawanna & Wyoming Valley R. R., recently completed, cost $90 per linear foot, inclusive of the shaft. This tunnel eliminates the only seriously objectionable grade in the entire system.

A Small Electrically-Operated Refrigerating Plant.

With the perfection of refrigerating apparatus in small units, mechanical refrigeration is coming to cover a very broad field, having almost unlimited application in the preservation of food products and the maintenance of low temperatures in many industrial processes. One of the most important fields for development has been in the application of such apparatus in small units to domestic and household purposes, for which mechanical cooling offers many advantages over the use of ice. In some cases the use of mechanical refrigeration will, of course, depend largely on the question of economy, while in others, cost is sacrificed for cleanliness, convenience and the ease of control of temperature and it is in this direction that the extensive development in small units has been made.

Of the systems now in use for the production of cold, the ammonia compression system occupies a pre-eminent position. The apparatus involved is of comparatively simple construction, is easy to maintain and the refrigerating medium is inexpensive. A number of designs of equipment have been perfected in small sizes which permit continuous operation with a favorable degree of reliability and, with the electric motor drive, may be operated with very little attention. In this form mechanical refrigeration will have an increasing application in places where the ice supply is indefinite or the handling of ice is inconvenient.

Ammonia Compressor and Brine Circulating Pump at the Gallatin Hotel.

An example of a small refrigerating plant which is notable for the economy of space occupied and its convenience of operation is illustrated herewith. It is a small ammonia compression equipment operated by electric motor drives, which has been installed in the Gallatin Hotel, at Uniontown, Pa. It serves a number of purposes in the hotel and with the degree of convenience unapproachable with the use of ice in the ordinary manner. It serves not only for cooling a number of ice boxes and also for cooling a beer cellar, but is used for the manufacture of ice for table purposes. The equipment consists of a 10-ton ammonia compressor of a two-cylinder vertical enclosed type, built by the Brunswick Refrigerating Co., which is belt driven by a 10-h.-p. Westinghouse induction motor. The compressed gas is condensed in a pipe coil condenser conveniently located on the side wall, from which the ammonia passes through a brine tank, cooling the brine by direct expansion. The cooling is accomplished by brine circulation throughout, the brine being circulated by a small centrifugal pump belt driven by a 2-h.-p. Westinghouse induction motor. Both motors are supplied by power from the lighting mains of the hotel electrical distribution system.

The manufacture of ice for table purposes is accomplished in the brine tank, in which ice cans, filled with fresh water, are submerged until frozen. The average output of ice per day with this method of manufacture is about six tons. The beer cellar, which is cooled by brine coil circulation, is 9x16 ft. in plan, with a clear head room of 7½ ft., having thus an interior volume of 1,080 cu. ft. This room is easily maintained at an average temperature of 40° Fahr. Of the ice boxes served, there are three, each 5x6 ft. in size and 7 ft. high inside, and a cook's box, 4½x5 ft. in size and 7 ft. high inside. Two of the ice boxes are used for freezing purposes and have additional cooling coil surface to maintain an average temperature of 16° Fahr. The entire plant is cared for by an inexperienced attendant.

A Cargo of Iron Ore amounting to 13,294 tons was recently carried from Escanaba, Mich., to South Chicago in the 600-ft. steamer, J. Pierpont Morgan, which was launched a short time ago. The steamer drew only 21½ ft. of water.

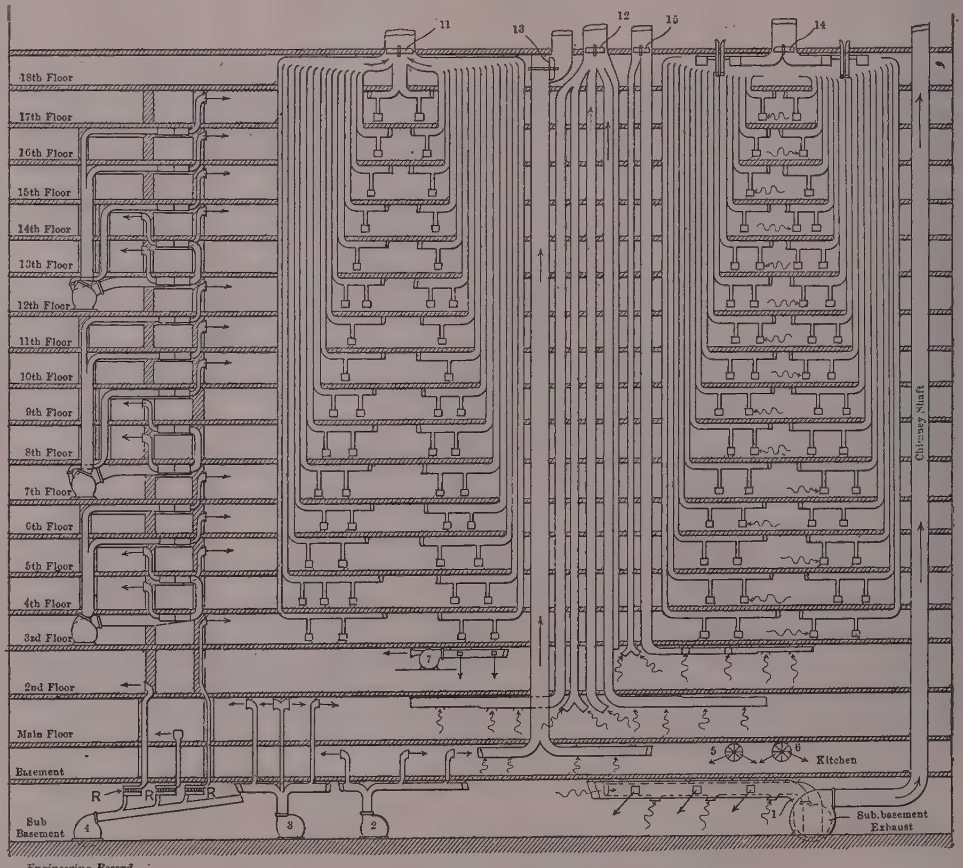
Heating and Ventilating Plant of the Hotel St. Regis, N. Y.

The Hotel St. Regis is an eighteen-story apartment and transient hotel of the most luxurious design and equipment, which was recently completed at Fifth Ave. and Fifty-fifth St., New York City. The building fronts 75 ft. on Fifth Ave. and 150 ft. upon Fifty-fifth St., and has a large open court space at the rear for light and ventilation. In accordance with usual apartment hotel construction in New York, the first floor is devoted to restaurants, a palm garden, reception rooms and parlor, the large office and lobby usual in hotel construction being omitted. The second floor is devoted to additional reception rooms and parlors, a library and a large banquet room, while the floors above up to the eighteenth, are devoted to the private rooms and suites for the accommodation of guests. The eighteenth floor is devoted in part to a servants' dormitory and the remainder to machinery for the ventilation system. The basement contains the large kitchen, refrigerators and supply and auxiliary rooms for the hotel service, while the power plant and mechanical apparatus are installed in the sub-basement.

The heating equipment of this building is of unusual interest on account of the use of the indirect steam heating system for all public portions and 550 guests' rooms in a building eighteen stories in height, direct radiation having been eliminated in all portions except in the servants' dormitory upon the eighteenth floor. For this indirect heating service a number of independent blower systems are used with cheese-cloth filter intakes, automatic temperature control on heating stacks and humidifiers for automatic regulation of the moisture carried in the air. The systems are in all cases designed to maintain, in connection with the exhaust ventilation systems, a uniform temperature of 70° Fahr., in zero weather, all rooms having exhaust vent connections through register openings, or fireplace flues. A feature of the installation is the sub-division of the heat supply to the guests' room upon the upper floors, into three nearly equal divisions, each of which is supplied by a heating fan on a floor underneath for upward delivery.

There are in all seven indirect steam heating equipments in the building which serve independent groups of floors, the general scheme of which sub-division is well shown in an accompanying diagrammatic vertical section of the hotel; in this diagram are shown the locations of all blower and exhauster equipments and by diagrammatic flue connections, the floors which they serve. The guests' rooms extending from the fourth to the seventeenth floors inclusive, are, as will be noted, operated by groups Nos. 8, 9 and 10, No. 8 on the third floor, supplying the fourth to the seventh floors, inclusive; No. 9 on the seventh floor, supplying the eighth to the twelfth floor, inclusive, and No. 10 on the twelfth floor, supplying the thirteenth to the seventeenth floor, inclusive. The first, second and third floors are heated by indirect equipment, No. 4 in the sub-basement, being supplemented, however, on the second floor by the tempered fresh air supply equipment, No. 7, located in a mezzanine gallery at the east side, and the first floor by the tempered fresh air supply equipment No. 3 in the sub-basement for ventilating purposes only. The kitchen and other portions of the basement and the basement mezzanine gallery are supplied in part by tempered fresh air supply equipment No. 2, in the sub-basement, the portion adjacent to the ranges and cooking equipment having a cold or tempered fresh-air supply instead, for ventilation purposes only. The sub-basement in which the mechanical equipment is located has a cold fresh air supply only, as heating or tempering is there unnecessary owing to the large amounts of steam piping and machinery. Direct radiation is used only in the servants' dormitory on the eighteenth floor, and in a number of special locations at entrances and under skylights for supplementing the indirect steam heating in extreme weather.

The general arrangement of one of the heating equipments for guests' room supply and a typical arrangement of distribution ducts above the corridor is shown in the accompanying plan of the twelfth floor, on which is located the heating equipment supplying the thirteenth, fourteenth, fifteenth, sixteenth and seventeenth floors. This equipment consists of two 6-ft. blowers with duplicate motor drives, the heating coils, air filters and a humidifier, which are located in a room 20 x 32 ft. in size upon the inner court side of the building, next to the elevator shafts. The room has louvred window intakes from the court, and next to these is located the air filter, which consists of the usual cheese-cloth type with staggered frames. Between the filters and the blowers are the tempering coils, with automatic control, and the humidifier. The two blowers on the opposite side of the room, are mounted side by side with shafts connected in tandem, and have duplicate driving motors, one at either side so that one motor is always held in reserve. The delivery duct work is carried out in three sections, one into a space above the furred ceiling of the twelfth floor corridor for the supply of the thirteenth and fourteenth floors, another connecting to the ducts above the fourteenth corridor ceiling for the fifteenth floor supply, and the third supplying similar lines of duct work above the fifteenth and sixteenth floor corridor ceilings for the sixteenth and seventeenth floor supplies. The arrangement is throughout, it will be noted, such that an upward delivery of the heated air is preserved in all connections.



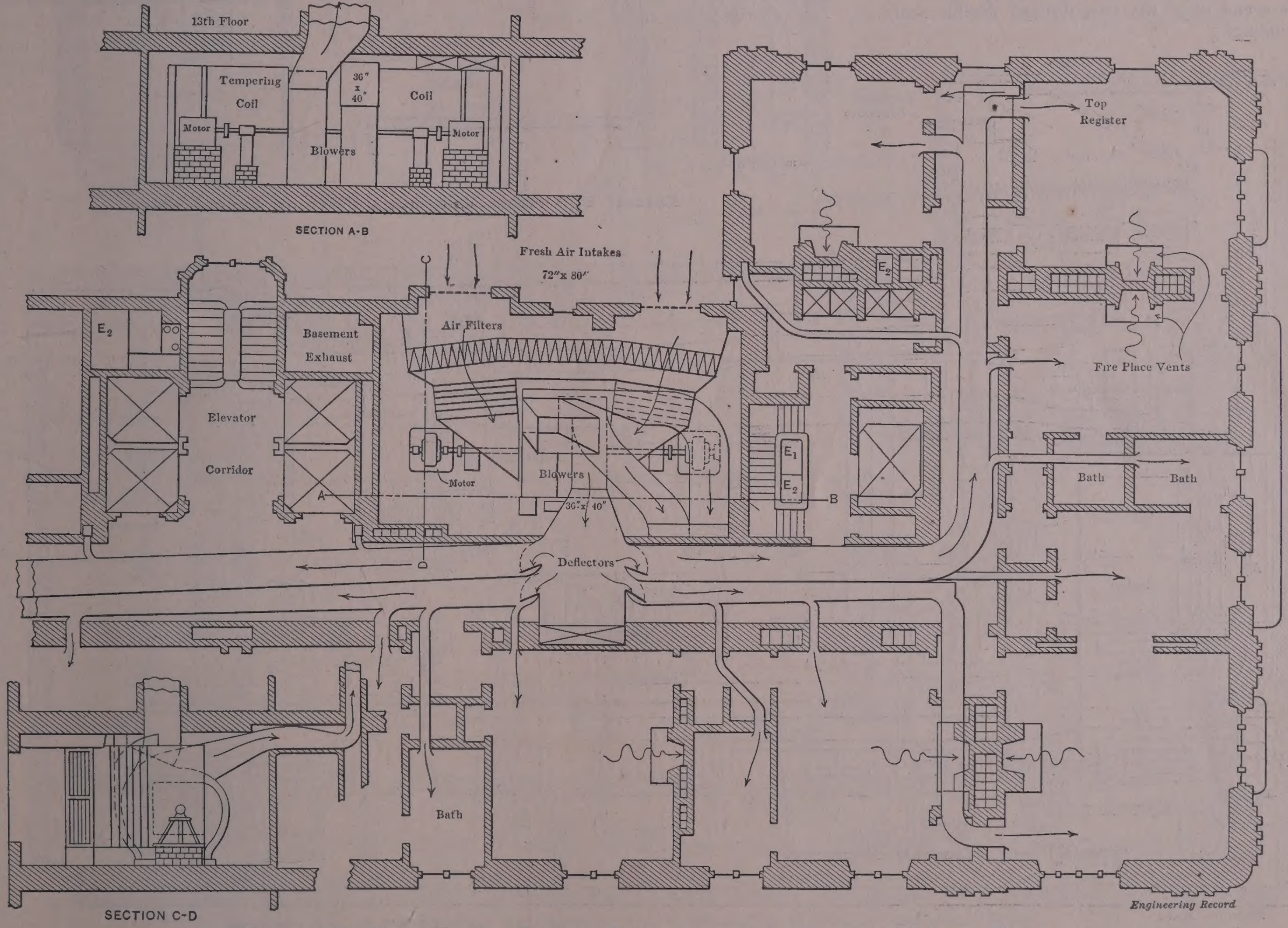
Engineering Record.

Diagram Showing Arrangement of Heating and Ventilating Equipments of Hotel St. Regis.

The blowing equipment of this indirect group is designed for the delivery of 40,000 cu. ft. of air per minute when operated to full capacity, and there are 56 guests' rooms on the upper floors which depend on it for heating service, the aggregate cubical contents of which are about 300,000 cu. ft. The intake windows are each 72 x 80 in. in size, providing thus a total intake opening of 80 sq. ft. The air filter consists of 66 cheese-cloth frames with air openings 2 x 8 ft. in size, which present thus a total area of filtering medium of 1,056 sq. ft., so that the velocity of air in passing the filtering medium does not exceed 40 ft. per minute at full duty. There are two sets of tempering coils provided, each of which has three 2-row and three 4-row sections 6 ft. wide by 8 ft. high, making the coils 18 rows deep; the sections are built up of 1-in. pipe screwed into separate cast-iron headers, presenting a total heating surface of 1,750 sq. ft. The blowers are full-housed, steel-plate centrifugal fans with top outlets, each with a 6-ft. blast wheel, 3 ft. wide, the blowers and heating stacks having been supplied by the B. F. Sturtevant Co., Boston, Mass. The duplicate driving motor equipment consists of a 14-h.-p. C. & C. direct-current motor mounted on a brick pedestal alongside either blower, each of which arranged for direct attachment to the tandem blower shaft by a flange coupling so that either may be connected or disconnected as required. Either one is of sufficient capacity to operate the fans at 180 r.p.m., when operating under maximum duty.

Each of the blowers of this heating group has two delivery outlets, one 36 x 40 in. in section, and the other 36 x 10 in. One of the fans has its larger opening on a top horizontal outlet and delivers directly through a 90x22-in. connection to the ceiling ducts above the adjacent corridor, five in number, from which delivery is made to the thirteenth and fourteenth floors, while the other has its larger opening as a top vertical outlet from which short connection is made to a 66x40-in. riser duct almost immediately overhead; the latter duct is carried up to supply the sixteenth and seventeenth floors. The two

36x10-in. delivery outlets open at the rear and deliver through 42x12-in. connections to a 84x18-in. riser carried up to supply the fifteenth floor. Complication is thus avoided by the use of short direct connections between the fans and duct work and the latter is designed for comparatively low velocities of delivery, the velocities of flow at full capacity ranging from 200 to 300 ft. per minute. The arrangement of distribution duct work on the guest room floors is shown by the plan of the twelfth floor, the system of duct work above the corridor ceiling of which is typical for all floors from the third to the sixteenth. The arrangement consists, in general, of four lines of ducts leading from the blower delivery connection down the corridors, two of which are for the main corridor on either side of the building center line, while the other two are for supply in the side wings. Branches are taken off to these to supply the heating registers of the various rooms, which are 10 x 12 in. to 14 x 22 in. in size, according to the location of the room, and are under automatic temperature control.



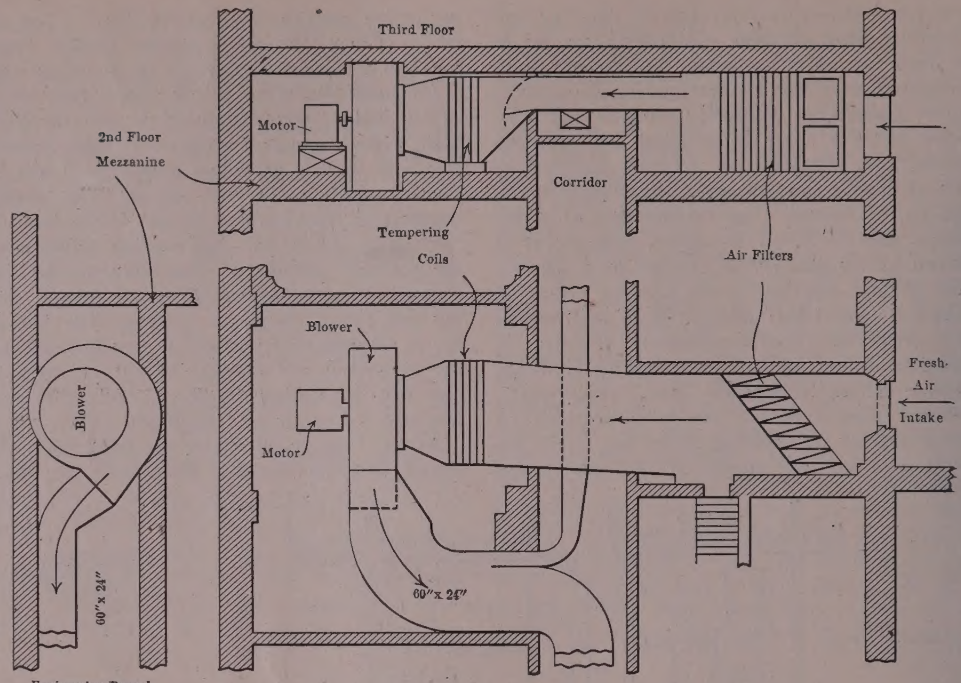
Plan of 12th Floor Heating System, Typical Layout for the Guests' Room Floors.

The second floor is supplied in part by an interesting tempered air supply equipment embracing a special ventilating system which supplies the public rooms on that floor. The system consists of a 5¼x2¼-ft. motor-driven fan with air filter supply and tempering coils, which equipment is conveniently located in a mezzanine gallery, 12 ft. above the main floor level in the east wing of the building where space was found available above a group of pantries and toilet rooms. Very limited space was available for the apparatus at this point, yet a working combination was found possible by which sufficient area of filtering medium was secured to avoid imposing undue velocity of air at the filters. The air intake is made through a louvred window opening into the interior court of the building with a free inlet area of 3 x 4 ft.; from this, air is drawn into a filter chamber 6 ft. wide by 6 ft. high, which contains a group of 15 filter screens, 3 x 6 ft. in size, providing thus a total area of filtering medium of 270 sq. ft. The supply connections from here to the fan intake is made through a 2x6-ft. flat duct leading across over the corridor passage of that wing, to the fan chamber where it enters the tempering coil casing and passes thence to the fan. The blower has a capacity of 13,000 cu. ft. per minute, and the tempering coil consists of twelve rows of pipe coils presenting 520 sq. ft. of heating surface and a free air passage of 300 sq. ft.

As has been stated above, the third floor, the second floor, and the first floor below are heated by an indirect equipment located in a fan room in the rear corner of the sub-basement. This room occupies a space of 45 x 50 ft. in the rear wing, and contains a 6-ft. blower, No. 4, which supplies the first, second and third floors with heat, a 7-ft. blower, No. 3, supplying tempered fresh air to the first floor only, a 5½-ft. blower, No. 2, supplying tempered fresh air to the basement, and an 8-ft. blower, No. 1, supplying cold fresh air to the sub-basement. All four of these blowers take air through a group of air intake shafts, which are carried up to the second floor level in the interior court and there hooded with a screened inlet. These open at their base into chambers supplying the air filters used in these systems, which are disposed, for want of space, on two levels, the upper, in a mezzanine gallery, 9 ft. above the sub-basement floor. This upper filter is connected to supply the sub-basement blower without preheating, while the three beneath are fitted with tempering coils, supplying blowers Nos. 2, 3 and 4. The intake shafts and connections are proportioned for intake velocities not exceeding 1,000 ft. per minute, while the filters have surfaces of sufficient area to permit filtering velocities of as low as 60 to 70 ft. per minute under full duty. The upper filter chamber has 47 filter screens, each 4 x 6¼ ft. in size, providing a total area of filtering medium of 1,175 sq. ft., and in the lower chamber, the filter equipment for blower No. 4 has sixteen filter screens, each 4 x 7¾ ft., giving a total area of filtering medium of 496 sq. ft., and the remainder, 46 screens with a total area of 1,000 sq. ft.

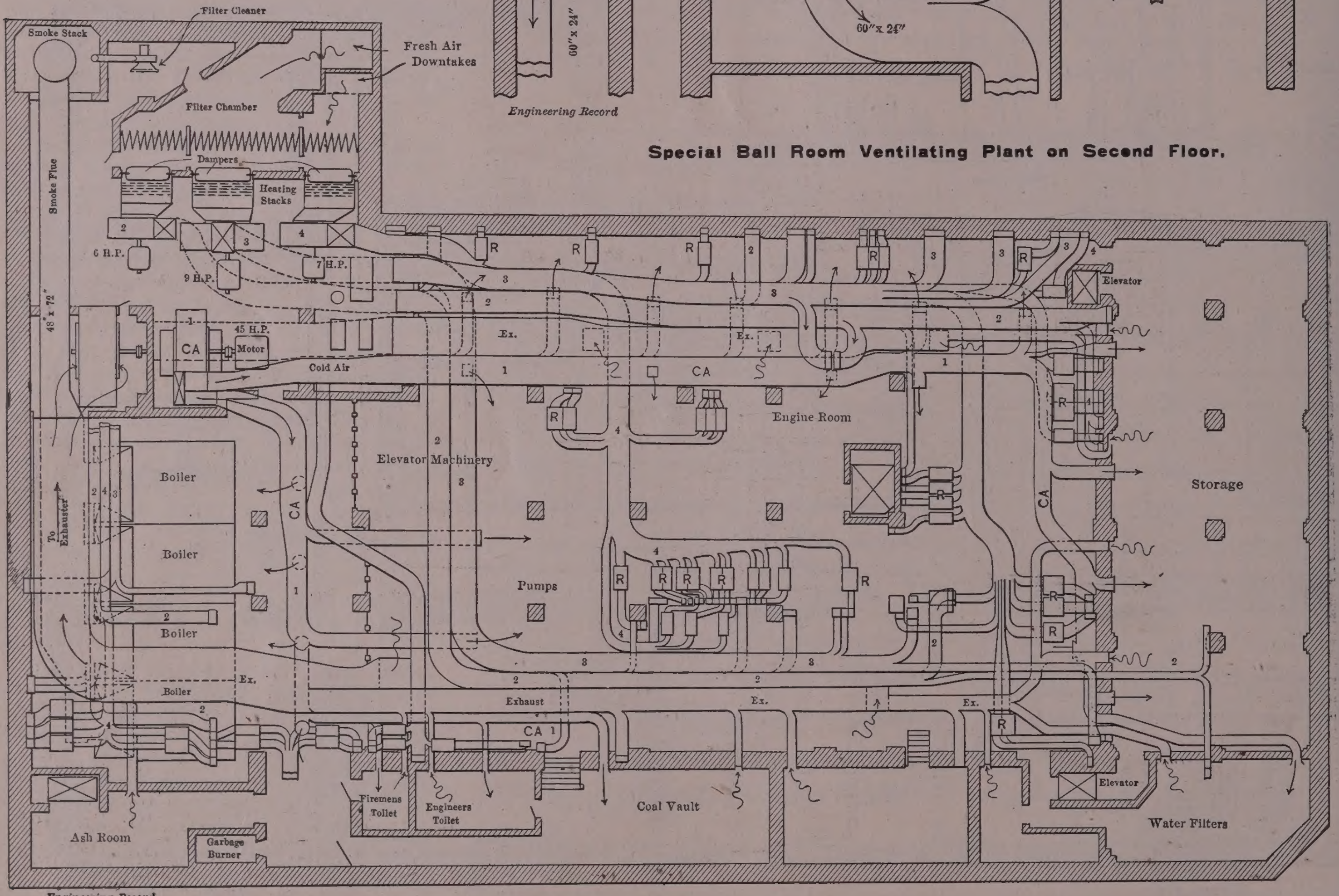
The tempering coils for the three blowers drawing from the lower filter chambers are installed in the supply connections from the filter chamber, that for blower No. 2 having 718 sq. ft. of heating surface, built up of single sections 6 ft. wide by 5 ft. high, four of 2 rows each, and one of 4 rows, making the coil 12 rows deep, while the coil for blower No 3 has 1,020 sq. ft. of heating surface made up of single sections 7½ ft. wide by 5 ft. high, three of 2 rows each, and two of 4 rows each, making it 14 rows deep. The remaining blower No. 4 has a tempering coil with 871 sq. ft. of surface, built up of single sections 6 ft. wide by 5 ft. high, three of 2 rows each, and two of 4 rows each, making it 14 rows deep. These tempering coils are all fitted with divided control, each coil having sections under control of cold air thermostats in the intakes and the remainder under control of hot air thermostats in the delivery duct connections of the blowers. The cold air thermostats are arranged to control outside sections and, for each system, are adjusted for different temperatures so that if the outside temperature raises to 40° Fahr. one section is cut out, and when to 50° a second section; the hot air thermostats similarly control the two inside sections of each system, the third section being cut out at 60° and all cut out at 70°.

The blowers are all three-quarter-housed steel-plate Sturtevant fans, with top vertical outlets, delivering to overhead lines of duct work, which supply the delivery systems on the floors above. They are located with short direct connections to the tempering coil casings and all have individual motor drives. The motors are all C. & C. direct-current motors operated from the 220-volt power mains of the hotel electrical distribution system and are equipped with speed-regulating starting rheostats allowing three variations of speed from two-thirds speed to full speed by field control. The motors are all mounted on brick piers and drive the fans through flexible shaft couplings.



Engineering Record

Special Ball Room Ventilating Plant on Second Floor.



Engineering Record

Arrangement of Ventilating Equipments and Duct Work in the Sub-basement.

The delivery duct systems for blowers Nos. 2, 3 and 4, are distributed on the sub-basement ceiling, those for the supply of the upper floors leading to riser connections at the side walls and column lines. The sub-basement supply consists of two main lines of duct, one 36 x 46 in., and the other 22 x 42 in. in cross-section, the latter supplying the boiler-room space. The branch supplying the engine and pump room has numerous openings 16 in. square on the lower side for distribution in working portions of the room, with branches into the adjoining store rooms at the westerly end of the sub-basement. The outlet openings in the boiler-room have swiveling nozzles to permit the blast to be directed immediately on the firemen when necessary. This system is designed and its outlet connections so arranged relative to the exhaust system as to cause rapid continuous changes of

Table I.

Speed, Capacity and Power Requirement of Motor Equipment of St. Regis Hotel.

System.	No.	Kind and size of fan.	Minimum speed R.P.M.	H.P.	Estimated amount of supply per minute.	Estimated amount of exhaust per minute.	Maximum speed R.P.M.	H.P.	Estimated amount of supply per minute.	Estimated amount of exhaust pr. min.	Contact points on motor regulating devices.
Supply, engine room	1	Sturtevant, 8 ft.x4-ft.......	86	15.2	19,000	—	170	57.3	37,000	—	15
Exhaust, engine room ..		" 10-ft.x5-ft.	86	—	—	37,000	170	—	—	70,000	—
Supply, annex lower floors		" 6-ft.x3-ft.									
Exhaust, annex lower floor		" 8-ft.x4-ft.									
Basement air supply.....	2	" 5-ft.x6-in.x3-ft. .	142	2.56	11,000	—	260	6.7	2,000	—	14
Basement air supply.....	5	Blackman, 36-in. diam.	356	0.67	6,000	—	480	1.6	17,000	—	4
Basement air supply.....	6	" 36-in. diam.	356	0.67	6,000	—	480	1.6	7,000	—	4
Basement exhaust	13	" 84-in. diam.	158	3.7	—	30,000	258	8.85	—	50,000	10
First floor air supply....	3	Sturtevant, 7-ft.x3-ft. 6-in. .	118	3.04	18,000	—	200	8.85	31,000	—	14
First floor exhaust....	15	Blackman, 72-in. diam.	188	3.52	—	26,000	326	8.85	—	42,000	10
Second floor air supply..	7	St'vant 5-ft. 3-in.x2-ft. 3-in...	132	1.2	7,000	—	220	2.8	13,000	—	14
Second floor exhaust....		Blackman, 60-in. diam.	215	2.4	—	16,000	362	6.3	—	28,000	10
Heating 1-3 floor	4	Sturtevant, 6-ft.x3-ft.	128	2.7	11,000	—	198	4.55	20,000	—	14
Heating 4-7 floor	8	2 Sturtevant, ea. 6-ft.x3-ft..	30	1.92	8,000	—	195	8.8	40,000	—	15
Heating 8-12 floor	9	2 " ea. 6-ft.x3-ft..	30	1.92	8,000	—	195	8.8	40,000	—	15
Heating, 13-17 floor.....	10	2 " ea. 6-ft.x3-ft..	30	1.92	8,000	—	195	8.8	40,000	—	15
Exhaust 3-17 floor......	11	Blackman, 84-in. diam.	142	3.85	—	28,000	238	6.9	—	50,000	10
Exhaust 3-17 floor	14	" 84-in. diam......	160	3.5	—	30,000	256	8.3	—	50,000	10
				48.77	102,000	167,000		140.80	247,000	290,000	

air in the entire sub-basement, the capacity of the combined systems being sufficient to change the air in the entire sub-basement area ten times per hour. The result is that unusually comfortable machinery room conditions are secured, the ventilation providing better working conditions than are ordinarily found in plants above ground level.

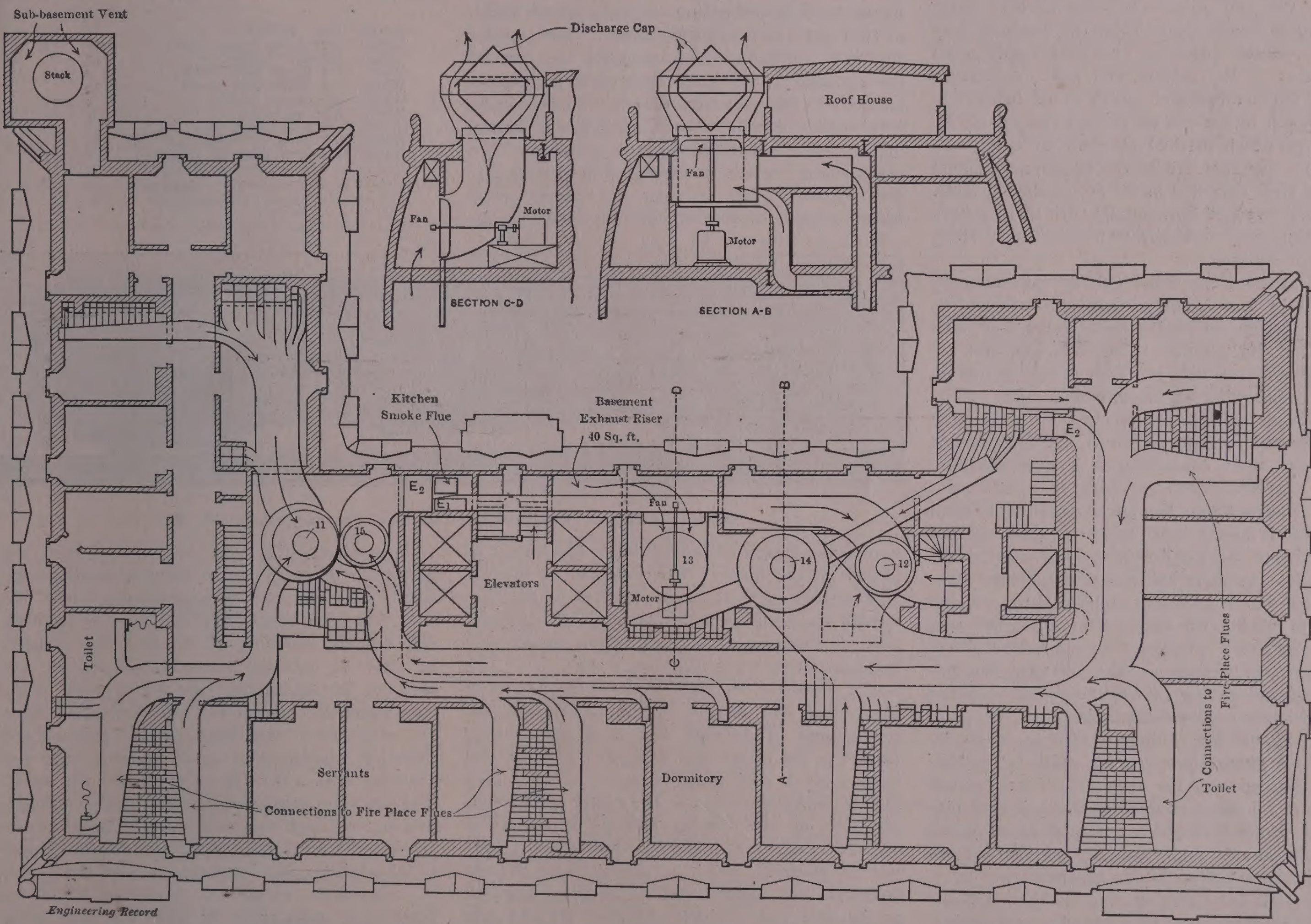
The kitchen supply, from blower No. 2, involves the delivery of tempered air through numerous outlets for the ventilation of that floor, the delivery duct consisting of a 24x36-in. duct on the sub-basement ceiling with numerous branches to the risers flues. The main floor tempered air supply system involves similarly the ventilating of the greater part of the first floor, blower No. 3 in the sub-basement delivering through a 30x42-in. duct to supply branches to wall riser flues. The outlet connections of these systems are in all cases located at elevated points for downward ventilation and for the greater part are under automatic control.

equipments in duplicate of thermostatic control apparatus on both the direct radiation of the indirect systems and also on the delivery duct outlet dampers. The supply register for each room has a multiple leaf damper of the usual type and another damper, which latter is operated by a pneumatic damper motor under control of a wall thermostat so located within the room as to encounter average temperature conditions within. The guests' room thermostats are adjustable, having thumb dials by which they may be set for any temperature within 10° above or below the normal setting of 70° Fahr. The equipment of thermostats, damper motors and valve diaphragm motors were installed by the Johnson Temperature Regulation Co.

Owing to the important influence which wind on the exterior of the building may exert on the heating of the guests' rooms, blower equipments Nos. 8, 9 and 10 have their tempering coils fitted for hand control, and their adjustments are attended to by an inspector who thus arranges the control within the various portions of the building in accordance with the direction of the prevailing winds, as well as the outside temperature. For this purpose the usual cold air and tempered air thermostats, as used for the tempering coils of the other heating systems, are replaced by pneumatic control valves which are located at a convenient point near the entrances to the fanrooms, so that the inspector can with the utmost facility adjust the amount of heating surface. The turning on or off of the valves on each heating coil section is thus accomplished by compressed air in a quick and positive manner.

Each of the seven indirect steam heating equipments is also fitted with a Johnson humidifier which regulates the humidity of the air delivered to the various rooms served. They are located in the coil casing of each system and consist of copper pans of suitable shape to fit into the connection between the coils and blowers, and are provided with a steam coil of brass or copper tubing for the evaporation of water contained in the pan. Water is maintained at a constant level in the copper pan by a float valve connecting to the house water service. Humidostats are located in the tempered air delivery ducts and are caused to regulate the supply of steam to the evaporator coil as is necessary to evaporate more or less water for moistening the heating air to the proper percentage and prevailing weather conditions.

Exhaust ventilation is similarly provided for all portions of the building, all of the upper floors from the first to the top of the building, having independent exhaust flues from each room to large disc exhaust fans on the eighteenth floor, which flues are either in the form of fireplace flues or independent wall riser connections. In addition, separate exhaust systems are provided for the toilet-rooms on these floors for absolute freedom from interference between the two systems. The exhaust systems are, as will be noted from the diagrammatic vertical section of the building, divided into two sections, one serving the east half and the other the west half of the building from the third to the seventeenth floors, inclusive. An independent system serves the second floor exclusively and still another, the first floor. The basement and sub-basement are exhausted by systems of gathering ducts concealed in furred ceiling construction, which lead to large vent risers extending up to the roof, that for the sub-basement comprising the steel stack of the boiler plant, while the basement exhaust consists of a large vent riser adjacent to the passenger elevator shafts. The sub-basement ventilation is maintained by a 10-ft. centrifugal exhauster in the sub-basement, while the basement ventilation system is exhausted by a 7-ft. Blackman exhaust fan at the top of the vent shaft.



Arrangement of Ventilating Equipments and Connecting Ducts on the 18th Floor.

An interesting feature of the equipment is to be noted in blower system No. 4, supplying the first, second and third floors with heat, in the delivery system of which reheater coils are used in each of the branch riser ducts for auxiliary heating, the purpose of which is for more exact control of the temperature conditions in the rooms supplied. These relay heating coils are located on the sub-basement ceiling, as indicated by R in the accompanying sub-basement heating plan, and consist of pin radiators of varying heating surfaces according to the delivery capacities of the ducts. The relay coils are enclosed in galvanized iron casings with heat insulation coverings and are operated by pneumatic motor valves under control of thermostats in the rooms supplied. This system provides in particular for the close temperature regulation of the rooms on the first, second and third floors.

Close temperature regulation is provided by

The arrangement of this exhausting apparatus is indicated in the eighteenth floor plan of the building. Of the five systems operated from this point the two principal equipments embrace the fireplace flue exhausters, one for the east side and the other for the west side of the house, which make connection with the fireplace flues by duct connections above the ceiling of this floor, as shown. The other exhaust systems comprise a separate fan for the first floor ventilation, another for the second floor, and still a third for the basement exhaust; the sub-basement is, as above stated, ventilated by a centrifugal exhauster in the sub-basement fan-room. A convenient arrangement of these fans was impossible owing to restricted space available, so that long, and in some cases, complicated, gathering duct connections were necessary. One of the fireplace flue exhaust fans is located, with the first floor and basement exhausters, on the west side of the elevator shafts, and the other fireplace flue exhauster and the second floor fan on the east side. They are in both cases enclosed in rooms apart from the servants dormitory corridor adjoining and have ample room for access to the motors and fans. A feature of the fan arrangement which is of interest is to be noted in the use of vertical fan drives, by means of which marked economy of space was secured. The fans are of the Blackman exhaust type, of sizes indicated in the accompanying table, and were arranged horizontally with their motors direct-connected vertically underneath by a short length of shafting.

Each of the fireplace flue exhaust fans has connections to four banks of fireplace flues and to several groups of wall risers connecting with bathroom and interior room exhausts, the arrangements of which connections are shown in the accompanying eighteenth floor plan. The second floor exhaust fan has a short connection to a 40x48-in. exhaust riser in a shaft nearby, while the other connection is a long 48x12-in. ceiling duct connection extending to a far corner of the building to an 18x30-in. exhaust riser from the second floor. Both the first floor exhaust fan and that for the basement have short direct connections to their flue risers, the former having three duct connections and the latter a single one into an exhaust shaft of 40 sq. ft. per sectional area. All of these fans have short direct discharge connections passing directly through the roof and ending in weather-proof discharge caps of heavy copper construction.

The exhaust fan equipment consists of Blackman disc exhaust fans, one of which is horizontally mounted and the remaining four vertical. They are all direct coupled to their driving motors which are arranged for variable speed operation, the speeds and capacities of the various units being indicated in the accompanying table. The motors for these, as well as the fresh air supply blowers, are operated by independent feeders in all cases from the power switchboard so that they are under direct control of the switchboard attendant in the engine-room. The electrical power supply system in the hotel, from which these motors are operated, will be referred to in detail in a subsequent article referring to the power plant equipment of the hotel.

The heating and ventilating equipment of the hotel was designed, together with the power plant equipment, by Alfred R. Wolff, consulting engineer, New York City. The building was designed for the owner, Col. John Jacob Astor, by Trowbridge & Livingston, architects, New York City.

A Large Suction Dredger for India has recently been built at Renfrew, England, which was designed specially for opening up new waterways. It has two suction frames with a total capacity of 4,000 tons of sand per hour.

New All-Steel Passenger Car for the Pennsylvania R. R.

The Pennsylvania R. R. has recently completed, at its Altoona shops, an all-steel passenger car intended for service in the New York City underground terminal. The steel construction was determined on in order to ascertain to what extent steel could be used in passenger-car construction, and to provide a fireproof car. Throughout the whole design of the car the aim has been to obtain a greater amount of strength than could be obtained with wooden construction; a complete steel framing, which could not be affected by fire; and an inside lining which is non-inflammable, and at the same time one which will not conduct heat or sound.

The principal feature of the construction of the body of the car is a center sill member in the form of a central box girder, 24 in. wide by 19 in. deep, extending throughout the length of the car, including platforms. This girder forms a backbone which supports the rest of the car, and at the same time gives such great strength to the body structure that there will be less possible danger to passengers due to breaking up of the car in case of collision. The sides of the car are composed of deep steel girders of very great strength and heavily reinforced, capable of withstanding any load in addition to the weight of the car itself which may be placed on the inside. The platform of the car is composed of steel plates attached to the center sill construction and covered with a cement finish in imitation of stone, which is spread over the steel plates while in plastic state.

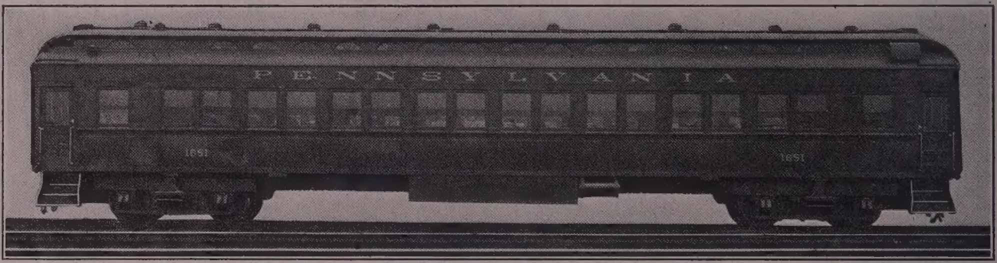
The vestibule end and corner posts are of a shape that will furnish maximum strength for the amount of material used, and are securely riveted to the center sills and end rail. The end door posts are of rolled material of very deep section, securely riveted to the center girder construction at the bottom and to a horizontal strengthening plate at the top, presenting a feature of strength which is absent from present passenger car construction. This great strength in the door and vestibule end posts will, in case of collision, and the body of one car rising above the body of the next car, tend to prevent the tendency for the underframe of the first car to sweep the superstructure of the second car from its underframe. The vestibule ceiling consists of a wide horizontal steel plate, reinforced in such a manner that it forms a girder braced to the side and roof framing of the car and prevents the collapse of the roof end.

The side framing is supported by cantilevers—four on each side, extending on either side from, and supported by, the center girder construction. Riveted to and rising from the side girders are steel posts of the strongest available section, spaced about 6 ft. apart, which support the roof and parts depending from the roof. Opposite side posts are connected by steel carlines of similar section, and the ends of the posts are tied together throughout the full length of the car by angles extending continuously throughout the length of the car and attached to the vestibule roof sheets at the ends.

In order to obtain the best possible results from steel construction, it was necessary to consider a re-design of the trucks to provide for a main central body frame of twice the depth that is used in wooden passenger car construction. Every feature of the truck has been carefully analyzed for the purpose of obtaining the maximum possible strength without excessive weight. The trucks consist of a frame work made entirely of steel and considerably stronger than truck frames now in general use; a bolster passing underneath the frames and provided with side bearings placed directly under the sides of the car to promote easy riding; a location of helical and elliptical springs which, from long experience, has been found to be most advantageous; axles of a large diameter, and rolled steel wheels

The general dimensions of the car are as follows:

	Ft.	In.
Length over buffers	67	5¾
Length over body corner posts	58	11¾
Length between bulkheads	47	4
Width over upper deck eaves	7	7
Width over lower deck eaves	10	1
Width over letter board	9	10½
Width over sheathing	9	9¾
Width inside of finish	8	11½
Height to top of car from rail	14	0½
Height to top of belt rail from rail	6	7½
Height to top of floor from rail	4	4
Height to bottom of car from rail	3	7⅛
Distance between truck centers	45	3
Diameter of wheels	3	0
Distances between centers of windows	2	11½



New All Steel Passenger Car for Pennsylvania R. R.

In building these new cars it has been the purpose to have an inside lining consisting principally of steel plates except directly under the roof, where the usual composite board is retained. The outside sheathing of the roof also consists of steel, so that the whole outside of the car presents one unbroken expanse of steel plate, with openings only for the windows. The doors are composed of steel plates pressed into a shape imitating wooden doors used in other cars and are filled with a cork filling to deaden the sound. The seats are composed of steel frames throughout, covered with fireproof plush. The foot-rests are of steel; in fact, no wood or inflammable material whatever has been used, except the top of the seat arm, which was made of wood for comfort of passengers, as steel was considered cold to the touch. Experiments will be made with seat arms made of metal, to determine the amount of discomfort and also whether it would be advisable to substitute metal. The inside flooring of the car consists also of a cement composition in imitation of stone, which in its plastic state has been spread over the foundation sheets, consisting of corrugated iron, which in turn are riveted to the center sills and side framing of car.

The car is equipped for electric lighting only, the current supply for which is furnished by storage batteries. The wiring has been carefully insulated and is carried in metal conduits. The storage batteries are carried in steel boxes, which are hung from the underframe of the car. The Pennsylvania R. R. standard ventilating system is used and also the four-pipe heating system. The paint used on this car is fireproof throughout.